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This publication is a compilation of papers presented at the USEPA National Conference of "Less Costly Wastewater Treatment Systems for Small Communities," held at Reston, Virginia, on April 12, 13, and 14, 1977. The focus of the conference was on sound and economical alternatives to conventional centralized wastewater collection and treatment systems for small communities.

Discussion included present governmental policy on wastewater facilities, and descriptions of major types of conveyance and treatment systems (with comparative costs). Examples were provided of successful and cost-effective installations which meet environmental requirements. Alternative organizations for maintaining and operating small facilities were also discussed.

Attendees at the National Conference included municipal officials, state health and water pollution control officials, consulting engineers, educators in sanitary and environmental engineering, and representatives from environmental and public interest groups.

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FOREWORD

The papers within this volume were presented at the U.S. EPA National Conference on "Less Costly Wastewater Treatment Systems for Small Communities," at Reston, Va., on April 12, 13, and 14, 1977. The focus of the conference was sound and economical alternatives to conventional centralized wastewater collection and treatment systems for small communities.

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This conference was co-sponsored by the following EPA offices: Environmental Research Information Center (Technology Transfer), Cincinnati, Ohio; The Office of Water Program Operations, Washington, D.C.; and The Municipal Environmental Research Laboratory, Cincinnati, Ohio.

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Administrator's Welcome

SMALL COMMUNITIES AND WASTEWATER TREATMENT COSTS: A NEW VIEW

*Douglas M. Costle**

I am very pleased that you are here today to help us take a fresh look at the critical issue of wastewater treatment costs, focusing especially on how these costs affect our smaller communities.

I am sure many would agree that there is an urgent need to find "less costly wastewater treatment systems for small communities," as the conference topic suggests. On how to pursue this goal, however, there is less agreement.

Fortunately, interest in this subject is growing rapidly. Our design conferences on this issue, held in Seattle and Philadelphia, were packed to overflowing. Already, similar conferences planned for Kansas City, San Francisco, and Denver, have evoked wide interest.

This conference is expected to move the discussion beyond case histories and technical questions to a consideration of policy. While we plan to focus attention during these three days on economical alternatives to conventional wastewater collection and treatment systems for small population centers, we also expect to explore governmental policy issues involved, including the need for public input in developing that policy.

We are honored today to have a keynote speaker who has been at the heart of environmental policy development, beginning long before the environment became a popular issue. Senator Jennings Randolph, chairman of the Environment and Public Works Committee, is also an expert on the problems and concerns of America's small towns. I am delighted he was able to join us today.

From his service in West Virginia, Senator Randolph knows first hand the character of our rural populations. My experience in Connecticut, where more than one-third of the population resides in small towns, has given me a special appreciation and affinity for smaller communities.

To many Americans, life in a small town represents an ideal lifestyle. Such settings appear to integrate man with his environment in the least harmful way. Their problems appear less complex; their pollutants are often less troublesome.

In setting national priorities and developing plans for abating pollution, the special conditions and advantages of our smaller communities have not always been taken fully into consideration.

This series of conferences is designed to build on these special advantages in developing acceptable alternatives to approaches based on conventional wisdom.

In our wastewater treatment construction grants program, some of the costs and planning approaches that have been developed now appear out of step with small town realities. The costs in initial capital, operation and maintenance of facilities, collector sewers, individual home connections, and so on, have exceeded residents' resources, in some cases.

In terms of the *national* costs, we currently have an $18 billion Federal program providing 75 percent of the costs of wastewater treatment construction. When the State and local share is added, we have a $24 billion program. Dollar outlays are expected to amount to close to $4.5 billion this year. More than 8,000 projects are underway, and we expect this number to top 10,000 this year.

More than half of our current grants, about 4,600, are for facility plans, the majority for small communities. New facility planning grants are being cleared at a rate of more than 2,000 per year, most going to smaller towns. These are the subject of our present concern.

Our new facility-needs survey has broken down the projected requirements for present and 1990 populations in this way:

- For large plants we need more than $11 billion.
- For small plants we need more than $10 billion.

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*Douglas M. Costle, Administrator
U.S. Environmental Protection Agency
Washington, D.C.

For the first time we are setting needs for small communities as high as for large cities. The *numbers* of small town projects have always outweighed the large city projects but, previously, the *dollar investments* have not approached the big cities, except on a per capita basis.

Costs and cost-effectiveness, therefore, become much more critical issues.

On the cost side, a survey conducted last summer of completed facility plans for communities under 50,000 in population found that capital and O&M costs of the 250 or so plans involved would exceed $100 per year for the homeowners in 40 percent of the towns. For 10 percent of the towns costs would exceed $200. The smallest towns, with fewer than 10,000 people, generally experienced the greatest cost, occasionally approaching $300 per household, or even more.

The survey found that the major cost was in conventional collector systems, where plans called for the installation of complete systems. Upgrading of existing systems was seldom considered in planning, nor were smaller collection alternatives, such as pressure or vacuum systems.

As a result of the findings, EPA is now taking a number of steps to be sure that the facility planners do consider the alternatives, and that the full costs, including operation and maintenance, are included.

- We are requiring that plans present *local* costs—capital and O&M—so they can be easily understood. This information must be presented at public hearings on the plans.
- We have changed our secondary treatment requirements to eliminate the need for disinfection, except where the standards for water quality in-stream require it.
- We are also relaxing somewhat the suspended solids limits for small treatment lagoons. A large proportion of the small towns in this country use these lagoons since they are fairly inexpensive, fairly efficient, and fairly simple to operate.
- We are modifying our guidelines for cost effective planning to make sure over-sized treatment works are not built.
- We are encouraging sanitary engineers, health officials and others to update their practice and criteria to take into account new alternatives, improved building materials, and accumulated knowledge and experience.
- We have also doubled our funding to the agency's research and development program in this area.

Our hope is that conferences like this one, together with the work and experience of planners, managers, and engineers like yourselves, will inevitably lead to more workable solutions to the wastewater treatment problems of small communities than those presently on the drawing boards. We are concerned about costs. Many small town homeowners have incomes well below the median national level. Our experience shows that costs that exceed the $66 to $130 per year cost for the typical homeowner in small towns will lay a heavy financial burden on many poorer residents.

Alternatives to relieve the local costs may be found in the add-on grants or loans from the Farmers Home Administration and other Federal agencies. The new loan guarantee law is another possibility. Under the new law, loans from the Federal Financing Bank to finance the local share will be guaranteed by EPA, if no other funds can be obtained at reasonable rates.

Our goal in this effort is to reduce pollution and raise the quality of living without imposing undue costs on localities.

At the same time, we seek alternatives that will help conserve our precious energy and water resources, particularly in drought-stricken areas. We are making every effort to assure the use of energy-saving ideas and the conservation of water. We are using our facility planning grants to help fund demonstration projects for some of the advanced design concepts. We urge engineers, planners, and community leaders to help in developing the reasonable and cost-efficient alternatives to fit the individual local situations.

One of my first official acts as EPA Administrator was to join many of Senator Randolph's friends in honoring him for being named "Resource Recovery Man of the Year."

Besides his continuing, vital role in promoting resource conservation and environmental protection, he has long been a champion of research into new technologies tailored to the needs and concerns of rural America.

In response to these concerns, my predecessor, Russ Train, pledged to redouble EPA's effort in this regard. And here today, Mr. Senator, I renew that pledge.

I am delighted that you were able to be with us today and we all look forward to your comments on this critical issue.

Keynote Address

RURAL AMERICA NEEDS SPECIAL PROGRAMS FOR SANITATION PROGRESS

*U.S. Senator Jennings Randolph**

As individuals, and as a Nation, it is not unusual for us to rely on familiar persons, ideas, and concepts. When we have what we think is a good idea, the natural tendency is to stick with it. The tools of our trade, whatever that trade might be, are often used in the same way. There seems a tendency to over-rely on trusted tools and methods, to stretch their use to fit as many applications as possible, or to attempt to alter our problems or circumstances to fit our old reliable tools.

This has been the case with our over-dependence on large, centralized sewage collection and treatment systems. We have attempted to take them from highly urban settings, where their economies of scale and efficiency are most suited, and apply them to the different and varied needs of rural America. Such systems are not suited to many of the 19.5 million households that are now unserved by public sanitation facilities. The estimated costs per home of $8,000 to $10,000 and more is evidence that we cannot use the same old tools we have relied on in the past in these situations.

Representing one of the most rural States in the country, I have been concerned with the need to provide the same advantages for rural families as those enjoyed by urban ones. As Chairman of the Senate Committee on Environment and Public Works, I have been concerned with the cost and effectiveness of our water pollution control program. As a member of Congress, I am concerned with the overall, long-range effects of such policies on our environment and our economy.

Because of these concerns, I have become increasingly aware of the need for a more comprehensive and flexible approach to economically balance the problems of rural sanitation and environmental quality. On February 20, 1976, I wrote to Russell Train, then Administrator of the Environmental Protection Agency, to express my concern that the intent of Congress was not being fully implemented with respect to Sections 104(q) and 105(e) (2) of the Federal Water Pollution Control Act of 1972. These sections call for an active program to find and use cost-effective alternative wastewater systems for rural areas. In his reply, Mr. Train outlined the Agency's efforts in this area and pledged increased efforts during 1977.

On October 26, 1976, in the Senate, I again expressed concern for the need of an accelerated program, using alternative systems funded by the Federal Government, to provide reliable, cost-effective sanitation for rural families.

Since my first letter to Mr. Train, the Agency has moved in a responsible way to increase its program to encourage and evaluate new alternative wastewater systems. The recent series of EPA regional seminars and this conference are important steps in the right direction. However, this is only a start and much remains to be done. It should also be noted that the Farmers Home Administration, which is specifically charged by Congress with the responsibility for meeting the needs of rural Americans, has an ongoing program to develop more cost-effective rural sanitation techniques, particularly with low pressure sewers.

The major efforts to date have been by private industry. In various parts of the country, a relatively few private businessmen saw the need for equipment specifically designed to meet the problems of rural sanitation—long before we in Washington began to understand the problem. For many years these businessmen have dedicated their energies and substantial capital to the development of reliable equipment and techniques for the collection, treatment, and disposal of wastewater in rural America. Some of these products and methods provide the added advantage of water reuse and water saving, which will become increasingly important in the near future.

To you, in this new industry, I urge that you make yourselves and your ideas known to your government. This could be most effectively accomplished through the establishment of a trade association for all alternative systems manufacturers. Such an association could present your views to those of us who must make policies and laws to meet the problems that our Nation and our people face.

It would be a mistake, in my judgment, for any of you to insist that your product or method is the single answer to this complex problem. Such a position, carried to its logical conclusion, merely places us where we began, with the mistake of over-reliance on a single tool.

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*U.S. Senator Jennings Randolph
D. – W. Va.
Chairman, Senate Environment and Public Works Committee

We at the Federal level should encourage the further development of promising techniques through an ongoing program that places greater emphasis on research. In the implementation of programs for rural sanitation, we must view the available options and select those tools most appropriate for a given situation. Whether it be individual aeration plants, package plants, low pressure sewers, or septic tanks, it is essential that we have the facilities from which to select the most appropriate and efficient combinations of collection, treatment, and disposal techniques.

It is equally important that regardless of equipment or techniques selected, that rural sanitation be provided to whole communities, small clusters of homes, and individual households under a system approach. Such a program was developed at the Boyd County, Kentucky project, providing public ownership and maintenance. Through this central management and ownership, there should be no hesitation in providing this basic public health service for each rural family, whether it lives close to other families or a mile down the road. Diseases associated with poor water and sanitation are highest in those areas without publicly owned, operated, and maintained sanitation facilities.

Because of the need for new ways to solve the problems of rural sanitation and environmental quality, I have become familiar with the various methods available as alternative systems. Perhaps because of this concern, our staff receives many inquiries asking for more information about alternative systems. There is a real need to make this information more readily available.

It is difficult to keep up to date on the research being conducted in widely scattered areas of the country. In the universities of California, Wisconsin, Connecticut, and Toronto, at Rutgers, Penn State and Dartmouth, significant work is continuing. Numerous projects and programs are also being carried out by private business, Federal agencies, and State and county governments.

To assure the maximum benefit of such studies, to avoid duplication, and to insure wide publication, there is an urgent need for more coordination. To provide a mechanism to coordinate present and future studies, I propose the establishment of a central clearinghouse for all information on alternative wastewater systems for rural areas.

Such a clearinghouse could perhaps be funded through the Environmental Protection Agency's Wastewater Research Division. It would insure that the great amount of research on this subject would be readily available to others concerned with the further development of alternative systems. Equally important, such a clearinghouse would insure that general information and data and research would be condensed into the most usable form of State and local governments and concerned citizens.

The Agency should evaluate the National Sanitation Foundation at Ann Arbor, Mich., as a possible operator for this clearinghouse. NSF has provided testing and sanitation standards for food service and other products for more than 20 years. Since 1966, NSF has worked to develop and upgrade standards for alternative wastewater systems through the coordination of health officials, industry representatives, and regulatory officials.

As with any important subject involving the complexities of public health, engineering, and various other sciences, we cannot expect total agreement on what is the best method for meeting the sanitation needs of a given area. Debate—vigorous debate—is essential on such issues. We must welcome different points of view by insuring that information developed through research is available in usable form.

As we have become more sensitive to our fragile environment, we have also begun to understand the interrelationships and interdependence of environmental matters. One of the consequences of our overdependence on large municipal collection and treatment facilities is that water drawn from the ground for domestic use is often treated and disposed of many miles away. This treatment technique, which is now an accepted procedure, does not permit the replenishment of local ground water supplies. The result has been the significant lowering of the ground water table in many areas. Coastal regions such as Long Island, Florida, and California are particularly vulnerable because, as the ground water table recedes, salt water has begun to fill the voids in these underground reservoirs.

In addition to lowering the ground water table, the use of conventional collection and treatment encourages wasteful use of water. These two factors increasingly contribute to local water shortages and restrictions of use. In one year, for each person, the typical flush toilet contaminates 13,000 gallons of fresh drinking water to carry away 165 gallons of body wastes. That's more than 50,000 gallons for the average family of four. We have been forced to search for new sources of energy and more efficient use of existing supplies. We must now begin to use our limited water supplies more efficiently.

The current serious water shortages in California should remind us that water is one of America's most precious resources. It is the life blood of civilization. But in the United States and elsewhere water shortages are becoming commonplace.

The world's fresh water supply remains relatively constant. The world population of four billion will reach seven billion by the year 2000. Each day in the United States an estimated one-quarter trillion gallons of water are drawn from our rivers, lakes, reservoirs, and underground sources for non-industrial purposes. Total daily water needs are now about 400 million gallons per day, and this figure is expected to double by the year 2000. Household use accounts for more than 30 billion gallons per day, and will approach 55 billion in the next 20 years.

Our major use of clean and fresh water is for agriculture. Some estimates place this use as high as 83 percent of our potable water supply. In 1960, the United States had 37 million acres of crops under irrigation. By 1980 we will have 50 million such acres. In fact, 30 to 40 percent of the world's total food supply is now dependent on irrigated crop lands.

The demand for food grows daily with the increase of the world's population. The amount of land under irrigation must be accelerated to meet the growing hunger.

It is shocking and tragic that throughout the world today, and every day, 10,000 people die of malnutrition. Hunger takes one life every nine seconds. And yet food production is not keeping pace with the world's growing population. Senator McGovern noted in 1975 to the National Conference on Rural America that "there is now less food per person worldwide than there was in the midst of the Depression 40 years ago."

It was estimated in 1975 that countries where hunger is most common must double their production of food by the year 2000 just to hold their own against rising populations. Consequently there is, and will continue to be, a heavy dependence on the United States to feed great numbers of the world's population.

Blessed with good lands and climate, we are the world's most efficient food producers. In 1973, the United States produced 45 percent of world wheat and flour, 70 percent of world corn, and 85 percent of world soybeans.

In addition to the moral obligations that our food production places on us, the maintenance and growth of agriculture is vital to the economy and health of our own country. Agriculture is the Nation's biggest industry with assets totalling more than $530 billion. From planting the seed, through all the steps involved to bring food to the family table, agriculture employs, directly and indirectly, between 14 and 17 million Americans.

The continued growth of American agriculture as a major source of world food supply, as a vital facet of the Nation's economy, is dependent on a continuous and reliable supply of clean water. Much of what we do now will determine the availability of clean water for the soaring demands of the future.

In addition to general conservation measures, two basic programs can help preserve our water supplies. First, in rural areas, we should encourage sanitary systems that return treated waters to the ground where they can replenish the source of supply. The use of efficient small on-site wastewater treatment systems producing a relatively high quality effluent can help accomplish this in an environmentally sound way.

The concept of spray irrigation, under study at Penn State University, appears to demonstrate the feasibility of this concept. Not only have the researchers been able to return water to the land without ill effects, but the resultant tree growth at four times the normal rate produces trees which are superior to normal growth for use in pulp products. This is the kind of efficient use of resources that we should encourage.

The second measure that can be used to preserve our water supplies is wastewater recycling. Tests at the Appalachian Commission's Boyd County project have shown that, with proper maintenance, water may be reused for sanitary purposes. This type of system can save the average family 40 percent of its total water consumption. Similar savings in water consumption can be realized through the use of composting and oil flush toilets.

The alternative systems for rural sanitation, in all forms, that this conference will discuss in detail, hold great promise for the future when used in a responsible manner through a public ownership or "system approach."

Yes, I see the promise of an improved quality of life for the people of rural America. I see the promise of making our water pollution control efforts more equitable and effective. I see the promise of progress toward an improved overall policy that will help present and future generations live in a sound and healthful environment. I see the promise in your dedication and commitment as you cope with the problems of people living on this fragile planet. I salute your constructive efforts.

CURRENT COSTS OF CONVENTIONAL APPROACHES

*Keith H. Dearth**

This morning we are going to look at the economic impact of our construction grants program on small communities. We will examine O&M costs as reflected in user charges and the costs of debt retirement which may or may not be included in the established user fees.

First, let us take a few actual cases:

Projection 1

Community "A" is a midwestern community adjacent to a large lake. Septic tanks were replaced by a conventional collection system leading to a tertiary treatment plant.

Plant size – 3,000,000 gpd

Users served – 1600

Sewered population – 4700

Total cost – $14,500,000

Local share funded by loans, bonds and assessments

Average costs to property owners after initial $1800 assessment:

Average hookup – $1,000

User charges – $175 to $200 annually

Tax levy – $300 per year per property

Total – $500 per year per family

Median income – $9,700 per family

Annual sewerage costs – 5% of median income

83% of users have less income than $10,000/yr.

Capital cost per capita – $3,100

Value of average home – $20,000

Capital cost per home – $9,100

Projection 2

Community "B" is a northeastern town, again adjacent to a large lake. Septic tanks and direct outfalls were replaced by a conventional collection system and tertiary treatment.

Plant size – 250,000 gpd

Population served –1350

Users served – 650

Plant designed to serve a population of 2500 even though the population has been declining in recent years.

Total cost of project to date – $4,200,000

Cost of plant – 75% EPA, 25% State grants

Cost of collection system–50% FmHA, EDA Grants

Balance–FmHA Loan, 5% – 40 year

Connection costs – $500 to $1,200 per connection

User charge, Annual, and debt retirement – $220/family

Median income – $6600 per family per year

Annual sewerage costs – 3.3% of the median income

82% of families make less than $10,000

Value of average home – under $20,000.

Capital cost per home – $6,500

What do these examples mean in human terms?

We have found that small towns have many older people often living alone. For both communities "A" and "B", approximately one-fourth the population is over 60 years of age mostly living on small social security payments.

One example is that of the 80-year old aunt of one of the selectman of the Board of Selectman of Com-

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*Keith H. Dearth
Office of Water Program Operations
U.S. Environmental Protection Agency
Washington, D.C.

munity "B" who had to pay over one-fourth her total $4,000 life savings for connection costs and is faced with a $200 per year sewage charge from her small social security income.

These people are proud to be self-sufficient and many would literally starve before they would go on welfare. In low-income community "B", only 3 people are on welfare.

What are their reactions to these high sewer charges? In community "B" over half the potential users have refused to connect in to the sewer. Many of those who have connected in refuse to pay the charges. Court action is being sought by several who want to keep their septic tanks. At the public meetings in both communities and over the telephone I've heard words like "bloodshed", "march on Washington", "fraud", "deceit", and other harsh terms. In other words—civil disobedience. Both sewer authorities have filed suits—community "A" against both the engineers and the contractors, and community "B" against the contractor. Publicity for a growing number of similar cases is being witnessed on national and local TV, in newspapers and magazines in States across the length and breadth of the country. These are States like Maine, California, Ohio, New York, Wisconsin, etc.

We first became concerned about the economic impact of our program on small communities approximately two years ago during our routine quality reviews of facility plans from our ten regions.

As we have gained experience with the costs resulting from the standard collection and treatment works we have become even more concerned. To attempt to determine the scope of this developing problem we studied 258 facility plans for pending projects from 49 States for communities under 50,000 in population.

Projection 3

The survey indicated that operation and maintenance plus debt retirement of the local share for recommended new facilities will cost in excess of $100 per household per year in 40 percent of the communities, and $200 per household in 10% of the communities. The major problem arose when of these 258 plans, 83 called for completely new collection and treatment systems. Three-quarters of the 83 indicated costs in excess of $100 per year per household and one-fifth in excess of $200 per household per year. Costs will even exceed $300 per household in several instances. Communities under 10,000 persons in general seem to have the most serious problem. By the way, these costs are from engineers' estimates, some made three and four years ago, so without a doubt actual costs will be higher. This next projection pinpoints the increase in costs of sewering per capita as less densely-populated, small communities are considered.

Projection 4

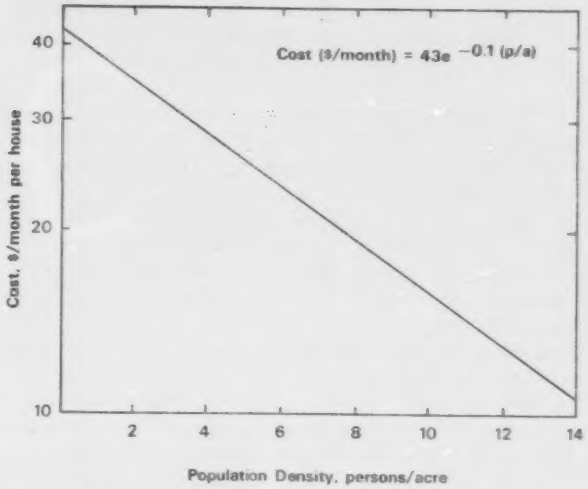

Figure 1. Monthly Cost Of Gravity Sewers

What are the factors which create these higher costs for small communities? One major factor is that the conventional collection system generally represents more than 80% of the total system capital cost in rural areas. Figure 1 clearly illustrates the relationship between cost and population density, which is primarily explained by:

- Greater length of sewer pipe per contributor
- Greater problems with grade resulting in more lift stations or excessively deep sewers
- Regulations or criteria which limit the smallest sewer pipe diameter to 8"
- Small communities cannot spread capital costs among larger populations sewered previously.

Another major factor concerns the design of the treatment works for small communites. Examples of improper design are:

- Over sophistication with accompanying high chemical usage, large energy requirements, costly maintenance, and operator expense when simpler methods would do
- Use of expensive construction materials such as non-locally-produced brick and block and terrazzo when a steel prefab and concrete would do
- Abandoning existing treatment works without economic justification.

It certainly doesn't help costwise when the design calls for six lift stations for 1350 population with four different makes of emergency generators conveying wastewater to a highly complex tertiary plant double the size required and requiring 24-hour operations. You saw the results in community "B" where it is over 70 miles to the nearest machine shop and capable mechanics.

An idea of the significance of these figures may be gained by analyzing Bureau of Labor Statistics figures concerning consumer expenditures for median income non-farm families and families in small communities.

The median income for the non-farm family was approximately $13,000 annually at the beginning of 1975. For small communities we have examples indicating that the median family earns from half to 80% of this amount—$6,500 to $10,000. BLS surveys indicate that the American family spends from 22% for the non-farm median family, to 30% for the small community family for total housing costs. Of this, 0.6% to 0.9% consists of "water, trash, sewerage" costs. Assuming the cost of each service is equal, then the national median family has been spending 0.2% of its income or $26 annually, and the small community median family has been spending 0.3% of its income or $20 to $27 on sewerage costs. Any costs much above this will reduce family funds available for discretionary and even necessary items. If you assume 1% of total income is the maximum bearable user charge, noting that this is 3 to 5 times that spent in the past by the median family, then $65 to $130 per year depending on the communities, is the maximum user charge which can be made without materially affecting the quality of life. We must not forget that by definition half the families earn less than the median income.

We are seeing actual user charges of $200, $300, and even $400 annually.

Projection 5

EXAMPLES
User Charges and Debt Retirement Costs

Dugger, Indiana	$240
Lake Villa, Illinois	$350
Napolean, Ohio	$350
Munising, Michigan	$150 O&M Only
Rangely Lake, Maine	$160 O&M Only

Actual user charges per family of 4 in 89 midwestern communities:

65% exceed $100 per year

31% exceed $130

9% exceed $200

5% exceed $300

Additional adverse economic impacts on the costs of goods and services from community businesses also will affect the user.

We feel that the state-of-art is such that provision and maintenance of adequate wastewater facilities for small communities are normally possible within reasonable costs.

Some costly projects are, of course, unavoidable due to high construction costs, soil and climatic conditions which do not lend themselves to inexpensive systems, or stringent water-quality standards requiring advance waste treatment. Where relief is essential in these situations, EPA is at this time primarily dependent on publicizing additional financial support available from other Federal agencies such as the Farmers Home Administration.

To summarize: Current costs of conventional sewering are sometimes too great to bear for families in rural and semirural communities. Actual annual user charges resulting from our construction grants program are ranging upwards of $200, $300, and $400 per family in some communities including operation, maintenance and debt retirement costs. Charges in excess of $65 to $130 per year could materially affect the quality of life for families making the median income or less.

During this National Conference you will receive facts and figures about alternative methods to conventional sewering. Unbiased consideration of all feasible alternatives and elimination of outdated codes, criteria and restrictions will result in the truly cost-effective solution to the specific water pollution problem and the lowest possible user charges.

EPA policy will be discussed during the last day of session.

ENVIRONMENTAL EFFECTS OF SEWERING SMALL COMMUNITIES

*Marilyn W. Klein**

Someone once said that, "Any beneficent public policy, if persecuted vigorously, is bound to conflict with an equally beneficent public policy." The struggles are often not between the good and the bad, but between the good and the good. It is clearly a good idea to clean up the waters of the United States and to make them fishable and swimmable, as called for by P.L. 92-500, the Federal Water Pollution Control Act Amendments of 1972. It is definitely in the public interest that publicly owned treatment works are constructed to meet existing pollution problems and that areawide waste treatment management approaches for point and non-point sources of pollution are developed and implemented. However, in the haste to develop sewer systems to serve communities large and small, other environmental "goods" are often insufficiently considered. Sewer systems, particularly in smaller communities, are sometimes constructed that are not environmentally and economically effective—and are put in place before an overall water quality management plan for the area has been developed.

Small communities sometimes find themselves drawn into environmentally and economically costly solutions that may not be in their own best interests because of how the Act is funded, interpreted, or administered. The lure of 75 percent Federal funding (and often 15 percent State funding) encourages communities to seek Federal dollars to correct their pollution problems. The requirement in Title II of P.L. 92-500 for areawide waste treatment management has often been misinterpreted to mean complete centralization of facilities, whether or not existing densities or locations make such an approach economical or desirable; and in some cases, in pursuit of a regional approach, recently built treatment plants are abandoned in favor of one central facility. A small community may be able to climb high on a State's priority list only if it is part of a regional system. Thus, in many cases, community is connected with community by large new interceptors that reach out across undeveloped land, opening the land to subdivision development that may not have been coordinated with local planning or budgeting for provision of services. Problems of runoff, erosion, non-point source pollution, flooding, and increased automobile reliance with increased air pollution and gasoline consumption often accompany such development.

Furthermore, perhaps because Federal funds are available with a small local share required for construction and because regional systems serve communities of varying size, such systems tend to be oversized to build in "sufficient reserve capacity," to provide a margin for error, or because they are predicated on excessive population growth rates for extended design periods and assume high per capita flow rates. Generally, when small communities attempt to solve the potential or real pollution problems that are created by increasing population density, failing septic tanks, or overloaded lagoon systems that are in violation of State and local public health standards, they opt for collection and treatment systems. Alternatives such as small scale systems, staging of treatment works, package treatment plants, small treatment lagoons, or community septage systems are often inadequately considered. Water conservation efforts in septic tank communities can avoid the need for sewers, and such efforts in sewered communities can save the enormous expense of enlarging and expanding current local or regional treatment facilities. With less water pumped from the groundwater supply, more will be available for needed river flow and quality. Elected officials and the general public, however, are not always aware of what the direct and indirect effects of sewering will be and what changes infrastructure investment will provoke in their community. And when a local community prefers a small localized system, it is not always possible to obtain State support with a high place on the priority list.

How do these concerns relate to the environmental review process under the National Environmental Policy Act (NEPA)? NEPA encourages public scrutiny of proposed Federal programs and projects. Agencies generally prepare environmental appraisals or assessments to determine whether a full Environmental Impact Statement (EIS) is necessary pursuant to Section 102(2)(C) of NEPA. According to the Environmental Protection Agency's procedures, based on Council of Environmental Quality (CEQ) guidelines, an EIS will probably be necessary when as a result of the project there will be:

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- Major land use changes;
- Changes in energy supply and demand;
- Increased development in floodplains or wetlands;
- Significant changes in ambient air and water quality or noise levels;
- Significant changes in surface or groundwater quality or quantity;
- Adverse effects on significant amounts of prime agricultural land or agricultural operations on such land;
- Significant effects on a residential area;
- Significant adverse effects on parklands, portions of rivers designated or likely to be designated as wild and scenic, or other public lands or areas of recognized scenic, recreational, archaeological or historic value;
- Problems of effluent or sludge disposal that require resolution; or
- Significant controversy over an EPA action.

In the past two years, several studies have included examination of EPA's environmental appraisals, negative determinations, EIS's, and treatment grants for their consideration of overall environmental effects. As EPA's programs often involve highly technical considerations, it is particularly important that the public is informed of the impact of proposed actions in public notices, hearings, environmental appraisals, and EIS's. In many cases, recent studies have found that environmental appraisals have not made the basis of need for the project clear, have not adequately considered the environmental and economic costs and benefits of the proposed project and its alternatives, and have not sufficiently addressed the impacts of proposed projects on wetlands, flood plains, and other significant environmental areas. In other cases where potential significant effects have been identified, an EIS has not been prepared.

Recent headquarters EPA guidance to the regional offices has encouraged improved environmental appraisals and better communication with interested Federal and State agencies about EPA construction grant projects to insure that sensitive environmental areas receive proper attention. EPA is also preparing guidance to the field to insure that environmental issues are not avoided by breaking down a major project with significant impacts into small components for review and that cumulative impacts of a wastewater treatment system as a whole are evaluated. EPA has also recently issued proposed cost-effectiveness guidance that is intended to improve project design so that it serves existing population centers with a carefully calculated reserve capacity. EPA has also issued guidance to the regional administrators encouraging the construction of less costly wastewater treatment facilities for small communities.

In addition to the construction, operations, and maintenance costs involved in large systems, such systems can create problems of groundwater depletion as water is piped away downstream where it is no longer available to local aquifers or to the upper reaches of the river. A breakdown in a high technology centralized plant will cause problems for all the connected communities and for the river's water quality when the effluent reaching it is insufficiently treated. Even when the effluent is of a reasonably high quality, downstream recreation, fishing, or water supply could be affected by a sudden inflow of treated sewage, particularly in a dry season when the river flow is low.

A large system built to overdraft surface water to flush sewage systems can cause hardship when seasons of drought strike—as we have seen recently in the west. Not only does a large water-demanding plant require careful maintenance but there are other difficulties as well. It may be difficult to site such a plant and its connecting interceptors. Keeping the plant and the interceptors out of the floodplain and away from wetlands, and avoiding prime farmland and archaeological sites is more difficult with a big system than a small one.

Reusing and recycling waste by spray irrigation or other land application methods and the management of sludge as a resource are more feasible when smaller quantities are generated and waste and resource systems are considered in an integrated way. A small community with a low technology system generates effluent and sludge primarily from household waste and will not have to worry about the carcinogens and other toxics and heavy metals that accrue when industrial waste is part of the system. Where industry is present in a small community, a careful pretreatment strategy and reasonable rate structure will make it possible to reuse sewage wastes as well as reduce the flows into the system.

If a project is proposed for Federal funding and it appears necessary to prepare an EIS to consider the effect of the proposal, the affected community has an opportunity to carefully examine its future. A good EIS will reflect consideration of sound alternatives—alternatives and impacts that the public can understand and review, prior to commitment to a specific proposal. Alternative locations, staging plans and capacities, and their economic costs to the locality along with their environmental effects on growth and sensitive areas will be examined in the EIS. As project proposals are developed, such issues as the extent of regionalization desirable, per capita per day consumption rates, design year, and reserve capacity require careful attention. It is also important to consider in an EIS the requirements of Section 201 of the Federal Water Pollution Control Act (and Section 101(b) of NEPA) for recycling of resources—both in regard to wastewater reuse and to sludge.

EIS's are being prepared that recognize the broad range of issues that must be dealt with when providing infrastructure facilities. In Region X an EIS was determined to be necessary in Jerome, Idaho, in a primarily agricultural county, where 8 percent of the county is in urban use. A major issue in the case is the 4 percent growth rate projected for the 20 year planning period—the effect of which would be to convert large amounts of undeveloped land to residential uses. This is of particular concern, since there is no formally adopted land use plan for the area to support this change. Prime agricultural land will be used for the treatment plant site and the project is controversial for its direct and indirect land use effects.

Also in Region X, near Seattle, an EIS is under preparation to consider community aesthetic and water quality concerns connected with the location of the treatment plant (presently on beachfront property), as well as issues regarding secondary treatment benefits, combined sewer overflow abatement, the risks of centralized or decentralized systems, growth and development, resource, energy and labor supply questions, sludge disposal, and the distribution of costs and benefits among population groups. Along the coast of Oregon, in Lincoln County, as a result of the EIS the community decided not to sewer.

Region IV in Atlanta determined that an EIS would be prepared for several proposed facilities in a portion of the greater Birmingham, Ala., metropolitan area. The primary intent of the EIS is to address publicly the direct and indirect effects of the project on water quality before going forward with its further development.

In Region V (the Chicago region), an EIS was prepared for a proposed system in Delaware County outside Columbus, Ohio, because the proposed project would affect a wild and scenic river, a significant recreation area, a valuable fishery, and archaeological sites, and it would have growth impacts. This project has been challenged in the consideration of alternatives that could avoid some adverse effects.

Region II will be preparing an EIS in Orange County, N.Y., to consider realistic population projections in the light of declining family size and immigration, resource and energy availability, sewer capacities, and corresponding development patterns that are likely to occur. Consideration of regional and subregional alternatives will include potential adverse land-use impacts, impacts on future costs of other public services, impacts on the quantity of stream flow, and the impacts on the assimilative capacity of stream corridors and on wetlands.

In Region I an EIS on a proposed treatment and collection system for three towns of Martha's Vineyard will carefully consider the need for sewering by examining the extent, location, and cause for failing septic systems as well as the feasibility of non-structural solutions in problem areas; it will examine the impacts of land disposal, and of on-lot disposal systems on groundwater. It will also examine the effects of treated wastewater and sludge on quality and quantity of groundwater in sewered and/or unsewered areas as well as any secondary growth effects on land use, water and air quality, and the social environment. The public will be informed and involved in data evaluation and interpretation and in screening alternatives.

Weston, Mass., recently voted overwhelmingly to build a community septic system designed to handle wastes from the town's center, currently served by overloaded individual septic and holding tanks. The town will either join a regional septage facility, contract with a conventional sewage treatment plant, or build a septage treatment plant of its own. To extend the life of the system, the town plans to use removable leaching field chambers, thus allowing the field to be cleaned periodically. The system will permit multi-purpose use of the leaching field area, as needed construction, and moderate capital and operating maintenance costs. It will avoid excess capacity, is designed to be cost effective, replenish groundwater, treat the sewage locally instead of sending it to Boston Harbor or elsewhere, and will have no adverse environmental impacts if State and Federal guidelines are followed.

And increasingly, when EPA has found that implementation of a proposed sewerage project would have significant regional and subregional urban development impacts, the grants have included conditions to address such impacts. The National Environmental Policy Act, EPA's procedures for its implementation, and EPA Program Guidance Memorandum No. 50 (issued in June, 1975) call for mitigation of secondary impacts when, without such mitigation, unplanned development with adverse impacts on air and water quality and the deterioration of the physical environment would result. The memorandum, titled, "Consideration of Secondary Environmental Effects in the Construction Grants Process," lists various mitigation strategies, such as:

- Phasing and orderly extension of sewer service;
- Project changes;
- Improved land use planning;
- Better coordination of planning among communities affected by the project;
- Sewer use restrictions;
- Modifications or adoption of environmental programs or plans such as Air Quality Maintenance Plans; and
- Improved land management controls to protect water quality such as sedimentation, erosion control, and floodplain management.

Several EPA projects reviewed by CEQ have included mitigation measures and grant conditions to address such impacts and to supplement State and local planning.

In Region X, as a result of the NEPA process, a proposed project in Tillamook County along the Pacific Ocean was reevaluated. The applicant is required as a condition of the grant to comply with local land use requirements when extending services, to evaluate development plans, and to provide services only to those areas selected as environmentally sound. This condition will discourage development that could adversely affect water quality in Netarts Bay and that would be inconsistent with the character of the area particularly near the wetlands.

Also in Region X, a proposed project in Fremont County, Idaho near Grand Teton and Yellowstone Parks— an environmentally sensitive and unique area — was changed in the design and location of the facilities. The Step II and III grants were conditioned on the county adopting growth management measures (consistent with the requirements in the Idaho Local Planning Act of 1975) to resolve secondary impacts on the area's resources, such as subdivision development that could follow construction of the sewerage facilities.

In Region II, a proposed Step II grant for a project in Chesterfield County, Va., southwest of Richmond, was modified because future growth facilitated by increased sewerage capacity could further degrade the Swift Creek Reservoir, a public water supply impoundment, and impede access to and recreational use of the reservoir. As a result of the environmental review pursuant to NEPA, a decision was made to fund a smaller expansion of the Falling Creek wastewater treatment facility than had been proposed. This decision was based on actual 80 gpcd sewage flow instead of the assumed 100 gpcd figure; revised population projections that discounted long term continuation of a recently experienced high growth rate; a recognition that the smaller modified facility would serve the existing population's needs as well as provide sufficient reserve capacity for moderate growth; and the cost-effectiveness analysis that found there was no savings in funding larger systems immediately versus staging construction as it was found to be necessary. In addition to sizing down the facility, the Step II grant was conditioned on the county's developing and adopting a management plan that included provisions to insure that growth in the affected watershed would be managed to minimize its adverse environmental effects upon the watershed and the reservoir.

In the East Bay of the San Francisco area, Region IX's EIS called for measures that would reduce auto dependency so that the provision of an improved sewerage system would not have negative effects on air quality. The applicant was to be responsible for securing agreements to provide mass transit facility and service improvements, automobile disincentives, and land use controls to insure that land-use planning and transportation controls are related and that the effect of increased sewerage capacity is not increased vehicle miles traveled with increased air pollution in the service area. As a result of the mitigation proposals, resolutions were passed by the local general purpose governments to perform additional studies, implement specific infrastructure investment proposals, and implement land-use measures. Grant conditions will require all reasonable steps to achieve implementation of these measures.

In Region I, a grant for a collection and treatment system on Block Island (New Shoreham on Long Island Sound in Rhode Island) was scaled down to serve a smaller, already developed service area and conditioned on not accepting discharge from new development on wetlands in accordance with State law.

The careful evaluation of impacts and improved attention to mitigation represents a significant step forward in substantive attention to environmental impacts called for by NEPA. Such attention should not be a burden if the environmental review is developed concurrently with the development of a facility plan — the EIS can serve as a tool to assist in the development of a better plan. Hopefully, as 208 areawide water quality management programs are developed and reviewed for their environmental impacts, facilities that are components of these will be better integrated into the water management program and will be more environmentally sound projects. And, hopefully, improved EPA guidance will lead to better projects.

It is important, however, that we recognize the conflicts inherent in beneficent public policies. No growth, or slow growth, may be wise policies when necessary to correlate resources to population and to preserve important environmental assets. Small systems may make resource management possible as well as reduce costs for communities. However, while the intent of Federal assistance for sewerage systems is not to subsidize development of subdivisions and shopping centers, small systems should not be used to keep newcomers out and to reduce housing opportunities. There must be an equitable approach to environmental benefits. With good planning and an informed public involved in decisionmaking, environmental, social and economic imbalances can be avoided and sound development encouraged. But solutions will not be easy.

The last quarter of this century is likely to see continued urban growth and continued suburbanization, converting rural land to residential subdivisions. New trends are emerging, however. Changing consumer preferences, rising housing prices, and national resource shortages are encouraging the development of more clustered, higher-density communities. Hence it is important that infrastructure investments be designed to enhance the positive features of these new trends in development. At an absolute minimum, local decision-makers and their planning advisors should be aware of the environmental, social and economic implications of their public facilities investment decisions. NEPA encourages such awareness on the part of all of us concerned with the physical shape of our common future. Hopefully by recognizing and addressing direct and indirect environmental effects of infrastructure investments, we can avoid aesthetic, economic, and environmental mistakes that reduce our future options.

EFFECTS OF DATED NATIONAL CODES ON COSTS OF SEWERED SYSTEMS

*Michael R. Alford**

One approach to cutting down the costs of sewered systems is to reexamine the design assumptions and engineering rules-of-thumb under which they have been constructed for years. Standard practice, as set down in such texts as Metcalf and Eddy's *Wastewater Engineering: Collection, Treatment, and Disposal, or Recommended Standards for Sewage Works* ("Ten State Standards") of the Great Lakes Upper Mississippi River Board of Sanitary Engineers has tended to close discussion of several important topics which together have a tremendous influence on sewer sizing. While there are undoubted economies of scale in sewer construction (most studies set the scale factor at about 0.5), unneeded capacity is no bargain, no matter how cheap it may be. My presentation today covers five design issues: the first three — minimum pipes sizing, per capita flow estimation, and infiltration allowances — are directly related to engineering; the last two — population projection and design-life economies — are planning related, but traditionally are interpreted by engineers.

MINIMUM PIPE SIZES

Both Metcalf and Eddy and the Ten State Standards call for 8" diameter pipes as the minimum size in any collection system. (See Exhibit 1). The populations served by 8" collector lines of minimum size typically fall short of their maximum flow capacity. Arguments in favor include ease of cleaning, safety against clogging, and low additional system costs, if any. Although the pipe itself is slightly more expensive, the increase is considered insignificant in relation to total installation costs; trenching expenses may even be reduced, since slope requirements for 8" pipe are less than for 6" pipe (the minimum practical size available for use). In some situations, however, the use of 8" pipe may significantly increase system costs, either directly or indirectly. Direct savings might be achieved in typical suburban installations, where some 70 percent of total system length may consist of minimum size pipe. Indirect savings may be the more important issue, however, since the use of 8" pipe tends to imply the oversizing of lines on down the system: at junction points, the engineer often tends to increase pipe diameters automatically, reacting to the collector as if its size were based on real flow requirements, not on the convenience of installation.

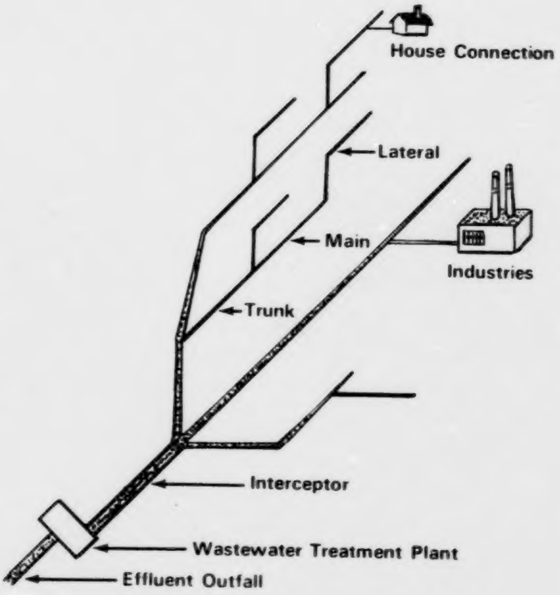
EXHIBIT 1

Minimum Pipe Size

Metcalf and Eddy	8 inches
Ten State Standard	8 inches
Most States	8 inches
Minimum Practical Size	6 inches

Population Equivalents
(100 gpcd/5 1 P/A Flow)

6"	507
8"	900



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PER CAPITA FLOW

A significant opportunity for system savings may be had in the area of per capita wastewater generation. Both sources quoted above advise the use of 100 gallons per capita per day (gpcd) for estimating flows, and EPA's Need Surveys have based cost estimates on 125 gpcd. (See Exhibit 2). Neither of these figures is defended by empirical data on actual household water use – rather, the figures have been established in large part by looking at systems from the treatment plant side, where incoming flows include many contributions besides domestic waste, the most important being infiltration from ground water, inflow from storm sewers or unauthorized connections, and commercial and industrial contributions. From the treatment plant end, implied per capita flows may range to many hundreds of gallons per capita per day.

In 1960, the Public Health Service Study published figures on average per capita water use and wastewater generation, showing 60 gallons per capita per day to be the mean water consumption, with approximately 42 gpcd returning to the sanitary sewer system. Tabors,[2] using data developed by Ligman,[3] synthetically estimated per capita water use to be no more than 89 gpcd under the most generous assumptions of behavior. Cohen and Wallman, in a study of an admittedly limited number of dwelling units in California, found an empirical range of wastewater generation of between 28 and 72 gpcd. Empirical data on the Boston Metropolitan District Commission water supply system suggests that per capita water use in this metropolitan area runs to about 62 gpcd.[4] In sum, the evidence suggests much lower wastewater generation figures should be used than are currently accepted in practice: 50 to 76 gpcd appears to be fully defensible for estimation purposes.

This has been recognized by EPA's new proposal for Cost Effectiveness Guidelines,[5] in which the figures shown in Exhibit 2 would replace the present 100 gpcd figure if fully documented flow records are not available, and if State standards did not take precedence. Even granting the scale economies of sewer systems, such revisions of per capita wastewater flow would indeed reduce the cost of systems considerably.[6]

An argument that has sometimes been brought forward in defense of standard estimating figures for per capita is that, as personal income rises, so will water consumption: additional appliances will be bought, and households will be more profligate in their habits. While to a certain extent this is true, the effect is not pronounced. In point of fact, appliances such as dishwashers may actually *reduce* water use, since they are more efficient than handwashing. Other convenience items like garbage grinders do not contribute excessively to water use, and many such appliances are no longer considered luxuries; their use is not closely tied to income. The large discretionary water uses that are tied to income tend not to be hooked into sewer systems. The obvious example is the swimming pool. Car washing is also related to income, but does not return waste to the sewers.

EXHIBIT 2

Per Capita Flow

Metcalf and Eddy	100 gpcd
GLUMR	100 gpcd
State Agencies	100 gpcd
EPA NEEDS Survey	125 gpcd

	Water Use	Wastewater
1960 Public Health	60 gpcd	42 gpcd
Ligman/Tabors (Synthetic)		89 gpcd
Cohen & Wallman		28 to 79 gpcd
Boston Area Estimates	62 gpcd	

Factors Reducing Per Capita Flow

- Energy Costs (Pumping, Hot Water)
- Supply Problems (Treatment Costs, Source Depletion)

Responses

- Low Water Use Appliances
- Low Water Use Sanitary Fixtures

More important to sewer sizing is the trend toward lower per capita water use overall. Both constraints on water supply systems and on energy use tend to encourage lowered per capita water use. Low volume flush toilets are expected to be more widely installed in all sectors of construction – so long as the unit is functional, flush volume is of no concern to the homeowner, and toilets contribute about half of the daily wastewater volume. Water conserving shower heads and a variety of other devices also will cut down on wastewater in future construction.

In sum, the rule-of-thumb figures used today are too large. The best estimation for sewer sizing would be based on observed wastewater generation in a community: winter water consumption rates (as indicated on water meters) are a good basis for estimation. Second best would be a rule-of-thumb figure on the order of 50 to 75 people gpcd, especially for service to new construction, where plumbing codes could require the use of efficient appliances. Estimates of industrial and commercial flow would be calculated separately. These are most accurately done either by direct metering (in the case of industrial process water use), or through land use or employee contribution estimates. Light commercial land use can accurately be estimated on a per acre basis. The standard texts also contain figures on wastewater generation on a per employee basis.

INFILTRATION

Infiltration rates are a separate design factor, and should not be incorporated into mean per capita water-use figures. One justification for the 100 gpcd flow figure is that it includes a margin for infiltration allowance. Such an estimation technique is defective insofar as it leads to the multiplication of infiltration allowances by peak-to-average flow ratios. Furthermore, it is also standard practice to make an additional allowance for infiltration wherever it is considered a significant problem.

Though sewer construction is an ancient science, there have been recent improvements in techniques. Pipes are now available in longer lengths, cutting down on the number of potentially leaky joints. Joints themselves have been improved through the use of PVC and rubber gaskets. Prefabricated, presealed manhole units are now commonly installed. Pipe materials themselves are now more durable, and less susceptible to damage in the long term. This has led to much higher performance specifications for new systems (see Exhibit 3), and reduced infiltration rates compared to older techniques, at least in theory.

EXHIBIT 3

Infiltration

Metcalf and Eddy	375 to 600 gpcd/mile/inch diameter
GLUMR	500 gpcd/mile/inch diameter "Normally" included in per capita flow
Concrete Pipe with Rubber Gasket	Negligible
Clay Pipe with PVC	Negligible

Peak/Average Flow

Should Exclude Infiltration Allowances

On the one hand, it is possible, on the basis of current product and construction specifications, to decrease the infiltration allowance for new systems (generally figured at an average number of gallons per day per mile per inch of pipe). On the other hand is field evidence suggesting that products are not performing to specification, and that installation is so poor that new systems leak more than old ones. To date, the evidence is not conclusive; long term performance of today's installations cannot yet be evaluated. However, where engineers have confidence in the specifications and installation quality of systems they design, new materials can cut down significantly on the overall sizing of pipes.

POPULATION PROJECTION

Small area population projections of the kind needed for estimating sewer system sizes, are tenuous at best. To demonstrate this, Exhibit 4 shows population projections for the City of Clay, N.Y., as developed by Tabors and Shapiro.[7] Using available census data, two sets of plots were calculated using standard methods of mathematical extrapolation. Actual growth in the community between 1960 and 1970 did not follow any of the graphic extrapolations based on 1940 and 1950 censuses: the real rate fell between the extremes. The curves plotted for growth over the 1970 to 1980 decade show a projected maximum 1-2/3 times the minimum estimates. Such uncertainties are compounded when the projection period is extended to the 50 years common in municipal sewer planning: 50 year projections for small areas can be little more than guesses.

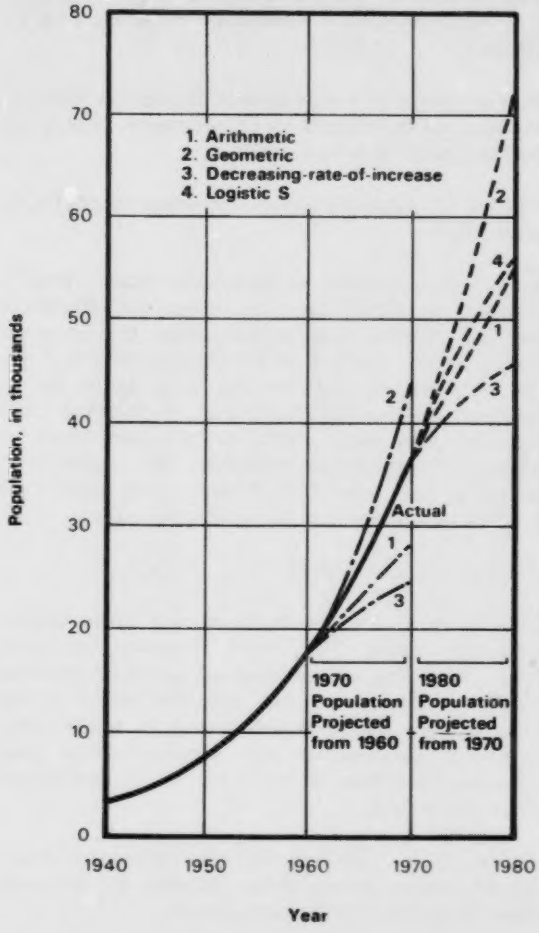
Aside from the statistical uncertainty of small area population projection is the observed fact that sewers interact dynamically with population migration and urban growth: even if a precise estimate of future population could be made, the introduction of the sewer system itself will change the nature of the assumptions on which the estimate was made, probably rendering it invalid. Sewers are often the missing link without which development cannot proceed; construction often releases a local spurt of growth as regionwide development pressure finds an outlet. This effect often appears to substantiate the overly optimistic population projections commonly made by sewer planners, but across regions, the consistent overestimation of future populations typical of sewer planning will result in money wasted on unused capacity.

The incentive for engineers is to overdesign: in the absence of serious local land use planning, each system typically is designed to handle the "worst case"—the geographically complete development of its service area. Since service areas for common gravity systems are geographically defined by large tributary basins, and since sewers—being a public health facility—cannot in practice be denied to anyone technically able to connect, the timing and location of growth within a sewer service area may be virtually uncontrollable. The solution, although obvious, is unpalatable to most communities: deliberate land use plans, or at least development ceilings, must be defined, and sewers sized to fit.

EXHIBIT 4

Population Projections

- Arithmetic
- Geometric
- Decreasing Rate of Increase.
- Logistic
- Sub-regional Step Down (208 Area)
- Land Use (Zoning)
- Ultimate Population of Tributary (GLUMR)



POPULATION PROJECTIONS
Clay, N.Y., 1970–1980
(Tabors, Shapiro)

Such a policy can lead, through the vagaries of population movements and development trends, to systems reaching their design capacities before the end of their design lives, or before their tributary basins are developed to capacity. Does this mean that the designer made an error? Not necessarily. It may mean that the sewer's apparent "undercapacity" is compensating for the system's dynamic effect on regional population growth patterns.

Although the distribution of new population within a community is its own affair to control or not to control, it does face regional obligations to absorb its share of growth. Areawide population projections showing the proportional distribution of growth within a region are being made by "208" Planning Agencies set up by the 1972 Amendments to the Water Pollution Control Act. The problem in the past has been that these projections are often in variance with the sum capacity of facilities planned within the region: due to uncertainties about migration patterns, the total capacity of sewer systems is often considerably in excess of that required to serve the total growth of the region. Bringing regionwide population projections into harmony with individual facility planning not only would make other municipal services easier to plan, it would save substantial amounts of money in sewer systems themselves.

OPTIMUM DESIGN LIVES FOR SEWER SYSTEMS

With most sewer systems designed for ultimate tributary basin population, systems traditionally have been built to serve populations that may not materialize for decades after construction of the system. In the past, with municipal bond rates on the order of 3 percent, design periods in the 50-year range were not unreasonable from a cost-effectiveness standpoint, but with today's much higher bond rates, reexamination of conventionally accepted design periods is in order.

Present value calculations of sewer costs suggest that shortened design periods are increasingly defensible from the point of view of cost effectiveness. Even assuming that additional capacity may have to be laid parallel to the existing lines at some time in the future, and granting that penalty costs for disruption will be paid for doing this, the cost differences between the options are minimal—under some circumstances (interest rates of 6 percent, population growth rates above 1.5 percent per year) the cost of two-stage construction is less than that of one stage.[8]

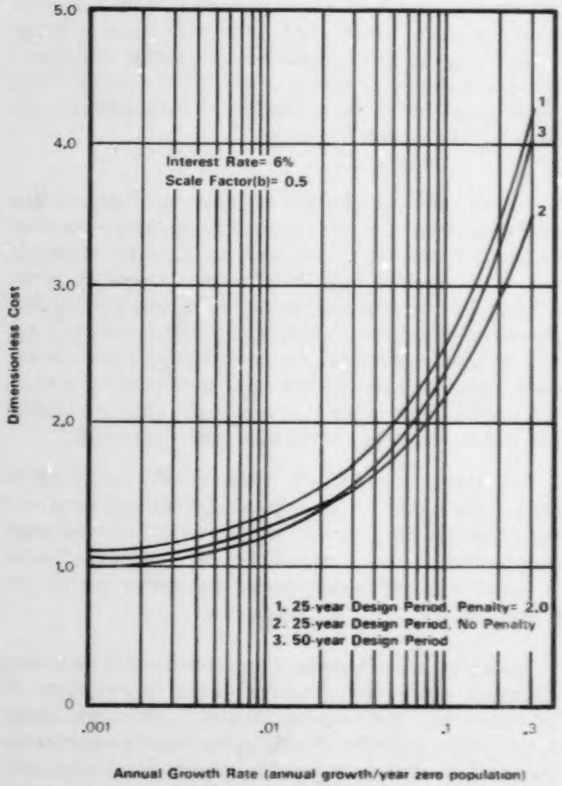
The graph in exhibit 5 shows relative construction costs under different assumptions of interest rates and design periods. Considering that interest rates on the order of 6 percent are likely to persist in the foreseeable future, it seems reasonable to reduce the design period for interceptor construction considerably.

Optimum design lives for sewer construction have been estimated by Binkley,[9] under various assumptions of interest rates, and relative inflation within the sewer construction industry. Assuming no relative inflation in the industry, Binkley found 21 to be the most reasonable design period for sewer construction (instantaneous discount rate = .04150, scale factor = .50). No penalty costs are assumed in this model. Perhaps the most persuasive argument in favor of shortening sewer design lives is the increased control gained over other municipal planning sectors. Since sewers interact dynamically with regional population migrations, potentially producing abnormally high populations and growth rates within their service areas, it is essential that population figures used in sewer design be the same as those assumed by other municipal departments, especially school, police, and fire departments. Often, decreasing sewer design lives gives increased planning reliability for these other municipal services. Where increased costs may be incurred over the long term, the studies quoted here suggest that they will be modest.

EXHIBIT 5

Optimal Design Periods (Interceptors)

Traditional	50 Years
California	20 Years
Binkley	21 Years (29 years @ 1.8% Inflation)



NOTES

[1] Select Committee on Natural Resources, United States Senate. Water Resource Activities in the United States. Washington, D.C.: Government Printing Office, 1960.

[2] Tabors, R.D., *et al.* Land Use and the Pipe. Lexington Books, D.C. Heath and Company. Lexington, Mass., 1976.

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[5] 40 CFR 35, Appendix A, Amendments proposed February 4, 1977.

[6] Even if the variance in actual per capita flows is considerable, with instances of personal contributions in excess of the mean figure used for design, this would not lead to system overload in the affected sections of the line if traditional minimum pipe sizes are in use. As indicated above, selection of minimum diameters is not based on flow requirements, but on issues of convenience and maintenance capability: flow capacities of collectors have more than enough excess capacity to handle a large variance in per capita contribution.

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THE ADEQUACY AND UNIFORMITY OF REGULATIONS FOR ON-SITE WASTEWATER DISPOSAL — A STATE VIEWPOINT

*Gary D. Plews**

INTRODUCTION

Background

Individual on-site sewage disposal regulations generally grew out of a need to protect the public health and a desire for in-home conveniences. Improper disposal of human waste has caused major epidemics. Most reference books on water-borne illness will cite many case histories of typhoid, cholera, and other disease outbreaks attributed to either improper collection, treatment or disposal of human wastes.

Historically, the methods for controlling communicable disease outbreaks attributed to sewage were limited to treatment rather than prevention. In seeking answers to the problems, the prevention concept was developed. Laws were passed that prevented the circumstances that caused the outbreaks from occurring. Thus, the idea of public health protection through preventive measures, including laws and regulations, was developed. The establishment of environmental health laws is old and can easily be traced to the Old Testament period. Regulations, therefore, have been around for a long time.

Problems

Even with this history, inconsistent laws and problems exist. Presently, the following appear to be the primary problem areas in the specific area of on-site sewage disposal.

1. State on-site sewage regulations are not uniform.
2. The purposes for the regulations change routinely.
3. Regulations are used to accomplish political needs rather than public health objectives.
4. There is a lack of program standards and clear delineation of responsibilities and authority.

BASIS AND CHANGE OF REGULATIONS

Public health has for many years been a basis for establishing a variety of laws at all levels of government. This public cause provides an extremely large and sometimes unspecific base from which to operate and also is the cause for some of the problems in the area of on-site waste disposal. Specific construction requirements are many times difficult to justify in terms of preventing disease. For example, how many illnesses are prevented by requiring four inch drainfield pipe as opposed to using three-inch drainfield pipe? This concept should be held in mind while growth of regulations from World War II to the present is traced.

After World War II, a mass migration of people to a new kind of life and existence began. Suburbia was born with all its accompanying problems of improper land use, restricted utility services and lack of standards for development. The development of new homes beyond the reach of proper utilities was the rule. Thousands of homes, whole communities and towns developed. The Federal and State government participated in funding the developments. HUD, FHA, State and local housing authorities supported the trend. At this point in time it appears that the septic tank or the on-site system moved from the country to the city type developments.

Problems then developed and housing units were vacated due to on-site system failures. Agencies reacted and passed new regulations and the Federal housing authority finally researched the problem. Studies began and continued, mainly at the University of California in Berkeley for a period extending well into the early sixties. Documents were printed describing the correct way to design systems. Local and State health departments accepted the materials and passed regulations using the new studies as a basis for their standards. In the meantime, technology on the subject did not advance significantly. The basic system used continued to be the 80-year old septic tank and drainfield. Most regulations covered this system thoroughly and stopped.

A significant change also occurred at this time. The basis for regulating on-site waste disposal began to change from a singular public health protection foundation to include consumer protection and environmental control. The use and misuse of on-site regulations began. The effort which started on the premise of preventing disease evolved to a very powerful tool that is used today by different levels of government to accomplish different objectives. For example, in many rural counties, the septic

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tank permit is the only mechanism available for controlling building.

A direct result in the evolution of control and standards is the diversity in regulations with administrative control found on four levels of government: city, county, regional and State. The effectiveness of the various regulations and approaches for the most part is unknown, since there is generally no comprehensive program evaluation or program standards.

PRESENT STATE REGULATIONS

Many of the present problems concerning regulations are then a direct result of changing objectives and use of the regulations for political control of non-waste issues. An examination of a select number of State regulations will demonstrate the point. I might add that it has been difficult to determine exactly what the various State programs encompass since they do change routinely. Another difficulty encountered was getting documents from the States. The responses were mixed and not complete. The samples I have chosen are limited to readily retrievable requirements from those States that responded to my request for information.

The first area examined was administration and the department most directly responsible for the day to day on-going administration, including permit issuance. An overview of Table 1 discloses that local health departments are, by-in-large, the chief implementers of on-site sewage regulations. The States have assumed various positions ranging from no program to some extremely stringent regulations.

Of the State programs reviewed, Idaho appears to have a unique, and perhaps the most workable, approach. Almost all the authority for the program is delegated to regional health districts. The approach allows for maximum flexibility on standards for construction to accommodate local conditions. Groups of counties that have common characteristics can provide some insulation from local vested interest groups and thus minimize political misuse of the standards. The arrangement can also provide a larger financial base from which to operate the program.

In Tables 2 through 6, there is a breakdown by State of various design requirements. It appears obvious, from reviewing the breakdown, that the *Manual of Septic Tank Practice* has had some influence. However, the diversity in certain requirements is questionable and demonstrates that many of the documents have been developed through political compromise rather than by sound technical advice. Setback distance and soil depth requirements demonstrate the influence of something other than technical recommendations (examples on Tables 3 and 5).

If one considers that approximately 30% of the citizens in the United States use on-site systems, a more concentrated effort is needed to develop and evaluate effective programs and standards. Uniformity on technical issues is desirable. It is presently very difficult to justify good, technically sound regulations when adjacent States are far less stringent and allow installations in unsuitable locations because of political purposes.

RESPONSIBILITY AND PROGRAM STANDARDS

Most State programs lack standards for evaluations. It is therefore difficult to judge program effectiveness. Because of a lack of standards, it is difficult to determine at what level the program should be administered: local, regional or State.

Before the selection of program administration responsibility is made, there should be some program standards and evaluation criteria established. Such standards or criteria should include the following:

1. A working knowledge of local conditions.
2. The ability to supervise the administration of the regulations.
3. The ability to communicate with the citizen being regulated.
4. The ability to finance the program.
5. The ability to understand the community organization.
6. The ability to keep abreast of the latest technology on wastewater disposal.
7. The ability to objectively review goals and objectives.
8. The ability to provide meaningful technical consultation.
9. The ability to legally intervene.
10. The ability to fund and conduct research.
11. The ability to provide basic documents and data.
12. The ability to coordinate and integrate the on-site sewage program with proposed legislative action.

A review of the criteria should suggest that local health departments appear to be in a better position to administer the basic program. The State's role should include program development, program support, and evaluation.

The Federal role appears to be more clear: research and State program support. An objective look should disclose there is a legitimate need for involvement by all levels. The roles should, however, be clearly defined and implemented. I submit that States, and certainly the local governments, have attempted to play their roles well even though inconsistencies exist. The Federal Government, in my opinion, has fallen far short of meeting its responsibilities except for recent activities including this conference.

Table 1. Basic Program Administration

States	Local	Regional	State	None
Alabama	X			
Alaska	X		X	
Arizona	X			
Arkansas	No Response			
California	X		X (Limited)	
Colorado	X		X	
Connecticut			X	
Delaware			X	
Florida	X		X	
Georgia	X			
Hawaii			X	
Idaho		X		
Illinois				
Indiana	X			
Iowa	X			
Kansas	No Response			
Kentucky	X			
Louisiana	X			
Maine	X		X	
Maryland	No Response			
Massachusetts	No Response			
Michigan	X			
Minnesota	No Response			
Mississippi	No Response			
Missouri				X
Montana	X		X	
Nebraska				X
Nevada	X		X	
New Hampshire			X	
New Jersey	X		X	
New Mexico	X		X	
New York	X			
North Carolina	X			
North Dakota				X
Ohio	X			
Oklahoma	X		X	
Oregon			X	
Pennsylvania	X?		X	
Rhode Island			X	
South Carolina	X		X	
South Dakota	X		X	
Tennessee	X			
Texas	X		X	
Utah	X		X?	
Vermont	X		X	
Virginia	X			
Washington	X			
West Virginia	X		X?	
Wisconsin	X			
Wyoming				X

44 – Responses

15–Local Control　　1–Regional Control
18– Local - State　　6–State Control
4–No State Involvement

Table 2. Septic Tank Design

	Septic Tank Capacity in Gallons By Number of Bedrooms				
States	1	2	3	4	5
Alabama	1000	1000	1000	1200	1400
Alaska	750	750	900	1000	1250
Arizona	960	960	960	1200	1500
Arkansas					
California					
Colorado	750	750	900	1000	1250
Connecticut	1000	1000	1000	1250	1500
Delaware	750	750	750	1000	1250
Florida	750	750	900	1000	1200
Georgia	750	750	900	1000	1250
Hawaii	750	750	1000	1200	1350
Idaho	750	750	900	1000	1250
Illinois					
Indiana	750	750	900	1100	1250
Iowa	750	750	1000	1250	1500
Kansas					
Kentucky	750	750	900	1000	1250
Louisiana	500	750	900	1150	1400
Maine	750	750	900	1000	1250
Maryland					
Massachusetts					
Michigan					
Minnesota					
Mississippi					
Missouri					
Montana	750	750	900	1000	1250
Nebraska	750	750	900	1000	1250
Nevada	1000	1000	1000	1000	1250
New Hampshire	750	750	900	1000	1250
New Jersey	750	750	900	1000	1250
New Mexico	750	750	900	1000	1250
New York	750	750	900	1000	1250
North Carolina	750	750	900	1000	1250
North Dakota					
Ohio	1000	1000	1500	2000	2000
Oklahoma	1000	1000	1000	1000	1250
Oregon	750	750	900	1000	1250
Pennsylvania	900	900	900	1000	1100
Rhode Island	750	750	900	1000	1250
South Carolina	890	890	890	?	?
South Dakota	1000	1000	1000	1250	1500
Tennessee	750	750	900	1000	1250
Texas	750	750	1000	1250	1500
Utah	750	750	900	1000	1250
Vermont	1000	1000	1000	1000	1500
Virginia		30 Hour Detention – 100 Gallons Per Person			
Washington	750	750	900	1000	1250
West Virginia	750	750	900	1000	1250
Wisconsin	750	750	975	1200	1375
Wyoming	750	750	900	1000	1250

Table 3. Absorption Field Design

States	Setback Distance Drainfield To Well In Feet	Setback Distance Drainfield To Surface Water In Feet
Alabama	50-75	?
Alaska	50-100	50-100
Arizona	50-100	100
Arkansas		
California		
Colorado	100	50
Connecticut	75	50
Delaware	50-100	50
Florida	75-100	50
Georgia	100	50
Hawaii	50	50
Idaho	100	100-300
Illinois		
Indiana	50-100	50
Iowa	100-200	25
Kansas		
Kentucky		
Louisiana	100	?
Maine	100-300	50-100
Maryland		
Massachusetts		
Michigan		
Minnesota		
Mississippi		
Missouri		
Montana	100	100
Nebraska	100	50
Nevada	100	100
New Hampshire	75	75
New Jersey	50-100	50
New Mexico	100	50
New York	100	100
North Carolina	100	50
North Dakota		
Ohio	50	?
Oklahoma	50-100	50
Oregon	50-100	50-100
Pennsylvania	100	50
Rhode Island	100	50
South Carolina	100	50
South Dakota	100	100
Tennessee	50	25
Texas	100-150	75
Utah	100	100
Vermont	100	50
Virginia	35-100	50-100
Washington	75-100	100
West Virginia	100	100
Wisconsin	50-100	50
Wyoming	100	50

Table 4. Absorption Field Design

States	Minimum Percolation Restriction	Sizing Methods
Alabama	None	Perc
Alaska	None	Perc & Soils
Arizona	None	Perc
Arkansas		
California		
Colorado	None	Perc
Connecticut	None	Perc
Delaware	Yes	Perc
Florida	None	Perc & Soils
Georgia	None	Perc & Soils
Hawaii	None	Perc
Idaho	None	Perc & Soils
Illinois		
Indiana	None	Perc
Iowa	None	Perc & Soils
Kansas		
Kentucky	?	Perc
Louisiana	None	Perc
Maine	None	Soils
Maryland		
Massachusetts		
Michigan		
Minnesota		
Mississippi		
Missouri		
Montana	Yes	Perc & Soils
Nebraska	No	Perc
Nevada	Yes	Perc
New Hampshire	None	Perc
New Jersey	Yes	Perc & Soils
New Mexico	Yes	Perc & Soils
New York	None	Perc & Soils
North Carolina	None	Perc & Soils
North Dakota		
Ohio	None	Soils
Oklahoma	None	Perc Test
Oregon	None	Soils
Pennsylvania	Yes	Perc
Rhode Island	None	Perc
South Carolina	None	Perc & Soils
South Dakota	Yes	Perc
Tennessee	None	Perc & Soils
Texas	Yes	Perc & Soils
Utah	None	Perc
Vermont	None	Perc & Soils
Virginia	None	Perc & Soils
Washington	Yes	Perc & Soils
West Virginia	None	Perc
Wisconsin	None	Perc & Soils
Wyoming	None	Perc

Table 5. Special Restrictions

States	Required Soil Depth Below Bottom Of Trench In Feet	Allows Surface Discharge
Alabama	4	?
Alaska	4	No
Arizona	4	No
Arkansas		
California		
Colorado	No Minimum	Yes
Connecticut	1.5	No
Delaware		
Florida	1.5	No
Georgia	No Minimum	No
Hawaii	No Minimum	Yes, Conditional
Idaho	4	No
Illinois		
Indiana	?	No
Iowa	1.5[a]	Yes
Kansas		
Kentucky	?	No
Louisiana	None	Yes
Maine	2	Yes
Maryland		
Massachusetts		
Michigan		
Minnesota		
Mississippi		
Missouri		
Montana	4	No
Nebraska[b]	?	No
Nevada	4	No
New Hampshire	4[a]	No
New Jersey	4	No
New Mexico		
New York	2	No
North Carolina	1	Yes
North Dakota		
Ohio	4[a]	Yes
Oklahoma	4	No
Oregon	1.5[a]	No
Pennsylvania	4	No
Rhode Island	3	No
South Carolina	6"	No
South Dakota	4	No
Tennessee	4[a]	No
Texas	4	
Utah	1	No
Vermont	4	No
Virginia	No Minimum	Yes
Washington	3[a]	No
West Virginia	4	No
Wisconsin	3[a]	No
Wyoming	4	Yes

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[a] Allows less with special design

[b] Guidelines

Table 6. Absorption Field Design Requirements And Sizing Methods

States	Minimum Spacing In Feet Between Lines In Feet	Minimum Soil Cover Over Trench In Inches	Range of Drainfield Widths In Inches
Alabama	6	6	18-36
Alaska	6	12	12-36
Arizona	6	12	12-18
Arkansas			
California			
Colorado	6	12	18-36
Connecticut	6-9	6	18-36
Delaware	6.5-7.5	9	12-36
Florida	6-8	12	18-24
Georgia	10	12	18-36
Hawaii	6	12	18-36
Idaho	6	12	12-36
Illinois			
Indiana	6-7.5	12	18-36
Iowa	7.5	12	18
Kansas			
Kentucky	?	None	?
Louisiana	?	6-12	12-18
Maine	10	2-6	24
Maryland			
Massachusetts			
Michigan			
Minnesota			
Mississippi			
Missouri			
Montana	6	12	12-36
Nebraska	6	6	18-36
Nevada	6	4-6	12-24
New Hampshire	6-7.5	6	12-36
New Jersey	6-7.5	12	18-36
New Mexico			
New York	6	12	24
North Carolina	8	12	18-36
North Dakota			
Ohio	6	6	8-30
Oklahoma	8	10	24
Oregon	10	6	24
Pennsylvania	6	12	12-36
Rhode Island	6	12	18
South Carolina	10	9	18-36
South Dakota	6	?	?
Tennessee	6	12	18-36
Texas	7	6	18-36
Utah	6-7.5	12	12-36
Vermont	6	6	12-48
Virginia	6-9	None	18-36
Washington	6	6	18-36
West Virginia	6	12	12-36
Wisconsin	10	12	18-36
Wyoming	6-7.5	6-12	12-36

SUMMARY

State on-site sewage disposal regulations have evolved from a variety of needs over an extended period of time. Some needs were justified, others, perhaps not. The existing State guidelines and regulations are not consistent or uniform and their adequacy cannot be measured. The regulations generally follow the basic design concepts outlined in the ***Manual of Septic Tank Practice*** which is a general and outdated document. The most widely accepted method for on-site sewage disposal is the simple septic tank and drainfield system.

Septic tank and drainfield design requirements vary considerably from State to State. Water course setbacks range from 25 feet to 300 feet, and soil depth requirements range from nine to four feet below the bottom of the trench. Nine of the 44 States responding allow the open discharge of treated effluent from sand filters, aerobic units or wastewater stabilization ponds. Sizing of a drainfield in most States is accomplished by a non-standardized percolation test. Less than half of the States surveyed address soil types, and soil classification systems for sizing.

There are some recent changes in State regulations that may be indicators of change:

1. Increased involvement in subdivisions and larger system approvals.
2. Increased involvement in providing standard design criteria for alternative systems.
3. Increased emphasis on establishing minimum lot sizes.
4. Increase in field research activities.

The levels of government involved in administering the on-site sewage disposal program must be clearly delineated. Basic administration of the program appears best exercised at the local level. State activities should include program development, program evaluation, research and technical support. The Federal role should be expanded in order to provide for more research, training and to provide up-to-date documents.

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[3] McGauhey, P.H., and Winneberger, J.T., Causes and Prevention of Failure of Septic Tank Percolation Systems, Sanitary Engineering Research Lab, University of California, Berkeley, California, 1964.

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Alabama
Alaska
Arizona
Colorado
Connecticut
Florida
Georgia
Hawaii
Idaho
Illinois
Indiana
Iowa
Kentucky
Louisiana
Maine
Montana
Nebraska
Nevada
New Hampshire
North Carolina
Ohio
Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
Wyoming

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ENVIRONMENTAL IMPACT OF ON-SITE SYSTEMS

*James F. Hudson**

The title of this portion of the program is "Environmental Impact of On-Site Systems", but I'm going to take a fairly broad view of the term "environment" and look at those impacts discussed earlier—comparing on-site systems and sewers to the extent possible. Over the next two days, you will be hearing about a number of case studies of new technologies, new management methods, and new ways to fit on-site and small-scale technologies into the Federal program. My concern, simply stated, is "If we do make on-site systems more common, what effects will that have?" Beyond that, I am also concerned with current on-site systems, which the Census says served about 20 million households in 1970. For those systems, the questions are:

- How much damage are they doing right now?
- What can be done about the failing systems? and
- What can be done to keep the good systems working?

My paper will be concerned primarily with conventional septic tank systems, since they are the on-site technologies with which we have the most experience.

As a researcher, my first step in preparing the talk was to look at the literature, and I found a paper entitled "Septic Tanks and Their Effect on the Environment," by P.H. McGauhey, where he identified three stages in septic tank research:

- In the early periods, when pressurized water supplies became common for rural areas, and there was concern for methods to dispose of the wastes but still protect the public health. However, little data was collected, and the systems were installed in very low-density situations
- In the 1950's and early 1960's, after government funding of mortgages and uncontrolled installation of septic tanks by suburban developers had led to numerous failures
- In the 1970's, as groundwater became an important concern.

I feel there should be a fourth period of interest identified, since we have recently learned that sewering is not necessarily the answer for all situations; this conference and other activities show the need to consider all solutions and choose among them, rather than just following simple rules which lead to unwise solutions.

The environmental impacts of septic tanks are numerous, but there are two which have generally been of concern: failure and groundwater pollution. Failure of septic tank systems is generally caused by complete soil clogging, so that the wastes are unable to pass through the soil layer and either rise to the surface, or back up from the tank into the household (or both). This becomes obvious relatively quickly, and leads to odors, surface water pollution, public health problems, and similar impacts. It is often the result of failing to clean the sludge and scum out of the septic tank so that they overflow into the leaching field, but can also be caused by high groundwater or poor soils which will not accept sufficient flow.

The other type of problem arises when pollutants reach the groundwater without being sufficiently treated. EPA requirements state that any discharge to groundwater in the neighborhood of existing or potential aquifers must be of drinking water quality, and this is generally the goal of septic tank/soil absorption field systems. However if the soil is fractured, or if the percolation rate is too high or the groundwater too close, the system will not treat enough to meet these standards. Too fast percolation can be just as bad a problem as too slow. The soils may also not remove heavy metals, some of the nutrients, or chemical wastes effectively, so that septic tank systems may require pretreatment before dosing with industrial wastes, photographic chemicals, or near lakeshores where eutrophication may be a problem. Nitrates in groundwater are likely to be a major difficulty in meeting drinking water standards.

Conversely, septic tank and other land application systems may be an important benefit to the groundwater, with one household providing the equivalent of 3½ inches of groundwater recharge annually. In areas where groundwater is being used for supply sources, and particularly where depletion is a problem, the use of septic tanks and on-site systems may be extremely important. The best planning practice for this situation is probably to estimate the total recharge from the septic tank/soil absorption system, and from other sources, and thus estimate the dilution of pollutants entering the groundwater.

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It is important to note that, while EPA requirements for treatment systems under the Water Pollution Control Act require drinking water quality at the groundwater, they do not require it at the effluent end of the septic tank. The standard is also extremely strict, since many pollutants will continue to be treated in the groundwater itself through soil contact, and the residence times before reaching wells and returning to the surface depend on distance. For any particular design, it is possible to estimate pollutant migration and see whether groundwater quality problems are possible. This is, however, an expensive process and the simple standard of having the water clean when it reaches the groundwater should be followed in most cases, and in all situations where Federal construction grants are concerned.

This covers the major environmental impacts from the systems themselves; minor ones such as odors, resource use, construction land disruption, and so forth also exist, but they are minor. The only other primary impact from the system comes from septage it leaves behind.

This septage is a strong waste, sludge and scum left in the tank after it settles or floats. For the 20 million households with septic tank systems, and an average of three-year pumping with a 1000-gallon tank, there should be about 20 mgd of septage generated nationally, which does not sound like very much waste. Septage is difficult to treat, however, involving COD of over 3000 mg/l, and total solids of over 30,000 mg/l. Experience with septage treatment is limited, though land treatment, landfill, and addition of the septage to either the influent or sludge systems of treatment plants have been tried. At least one septage treatment plant is also being funded under the construction grants program, serving Sudbury and Wayland, Massachusetts, and EPA is testing septage treatment at conventional plants.

At this point, we do not know where most of the septage goes. It seems likely that large quantities are simply pumped into manholes, for discharge either to treatment plants or to rivers; large quantities also enter the soil through septic tank systems which are never pumped out, and which overflow solids. Since the waste has been decomposing in a highly anaerobic environment, but is otherwise relatively clean (few pathogens, few metals), land treatment may be the method of choice in the future. At this point, the research still needs to be done on effective septage treatment.

The secondary impacts of septic tank and other on-site disposal systems have to be evaluated. Lack of sewers has, in some areas, led to complete building moratoria; in others, it has justified lot sizes up to 5 acres, because of the need to use septic tank and soil absorption systems. Sewers can clearly be used in higher densities than septic tanks, but the critical cutoff is still open to question. While it is not a major concern for small communities, the subject of this conference, cutoff densities from 1/4 acre to 2 acres per field have been suggested, and may even be appropriate depending on the conditions. There is no good rule of thumb, and our data on system outputs is generally poor. In general, though, septic tanks and soil absorption systems should be accepted in any situation where the soil will clean sufficiently, and where effluent entering the groundwater will be diluted enough by the percolating rainwater to reach acceptable levels. While the information was not included in Gary Plews' talk, the variation in maximum septic tank densities is enormous, and rational bases for setting standards need to be developed.

The secondary impacts of allowing on-site systems as alternatives to sewers have to be considered. Leapfrogging is the result, as developers use the cheap and available land rather than waiting for parcels near the existing infrastructure. This may lead to greatly increased municipal service costs, for roads, storm drains, busing (both school and mass-transit), solid waste pickup, and other utility services. Most of these services cost more when provided on a dispersed basis, so that development controls based on the location of infrastructure make sense. Development near sewers showed that they were often more important than master plans in determining what went where. Now, planners and engineers may work together to provide infrastructure, only to find that development occurs far away, and is expensive to service. The secondary impacts of on-site systems may be large, and need to be considered in allowing them.

Besides these economic impacts on the community, the economic impacts of the on-site system itself need to be considered. The sewer systems described earlier may include a total capital and O&M cost of $100/household per year, without including the $500 – $1500 for the house connection. As an alternative, most unconnected households already have septic tank systems in place, and most of these may work adequately (though no one knows). The added cost of sewers is a very large burden. In areas where on-site systems fail, in new developments, or in areas where the on-site systems simply need replacement, the economics are much closer. A tank plus 500 square feet of leaching field, with maintenance on a regular basis, may cost $150/year for the household, comparable to sewering, and mound systems, aerobic systems, and the like will only show increased costs. Therefore, the main gain is in areas where densities are low so that sewering costs are high, or in areas where septic tank systems already exist, and complete replacement is not required.

MITIGATING MEASURES

Every environmental impact statement discusses mitigating measures, and that is also a useful concern in analyzing the environmental impacts of on-site systems. Most of the effort in the past has been on design – on finding better ways to build on-site systems so that they can be applied more widely. On the other hand, most failures seem to be the result of poor installation (e.g. on poor soils), and of insufficient maintenance. The tools we use may be insufficient in some cases, but our management of them is ineffective and needs to be improved.

In the design area, we should look for procedures which will reduce the maintenance requirements, increase the life of septic tank-soil absorption systems, and improve their performance. One method for doing this is the alternate leaching field concept, which allows the soils to regularly rest, and regain their cleaning capacity. Each year, a valve is turned to divert flow from one set of parallel fields to another, preventing major long-term clogging. Figures 1 and 2 give an example. Another idea is an overflow sensor, which could be electrical, or could simply be a blocking plug. Overflowing sludge and scum cause many, very expensive, failures of the soil absorption field, and a sensor which would monitor the sludge level and alert the resident could save large amounts of money. One simple version just blocks the outlet pipe so that the waste backs up instead of destroying the field; this is unhygienic, but quickly convinces the resident to clean the tank.

In installation, it is obviously important to get the pipes placed parallel and level, yet this is often missed. Similarly, it is important to test soil percolation, yet percolation tests show wide ranges in their results and are difficult to trust, especially when carelessly performed, or when done by people with an incentive to find a good result. Connecticut data has shown that systems installed in dry years fail more often than systems installed in wet years, simply because the soils appear to be better; careful combination of soil data and percolation tests seems to be the best practical alternative now, but the emphasis should be on the careful.

The main area of emphasis, however, should be on maintenance. EPA may be willing to fund public management systems, pumping trucks, and communal on-site treatment and disposal systems; the O&M, though, will remain the responsibility of the community. This can be done as part of a community system, going along with the public ownership of the on-site systems. However, it is also possible to use a regulated industry approach to ensure that tanks are maintained, pumped, and inspected. Under this alternative, each homeowner would be required to have a permit for his or her on-site system,

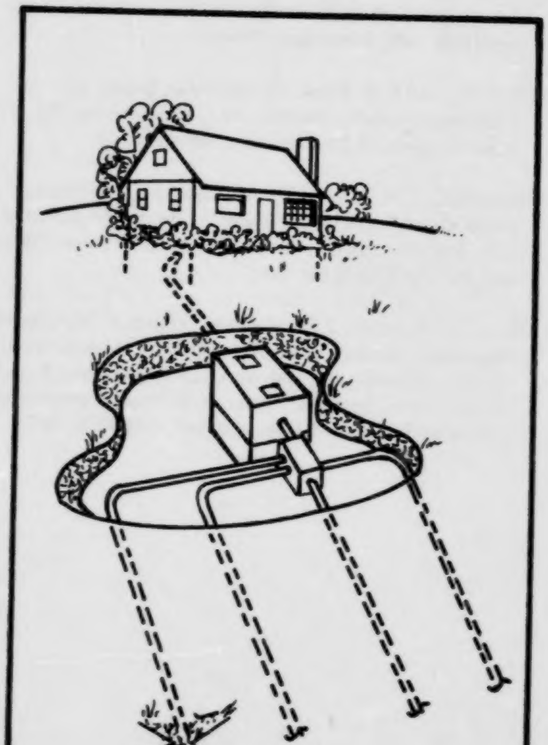

Figure 1. Layout of a Field with an Even Number of Trenches

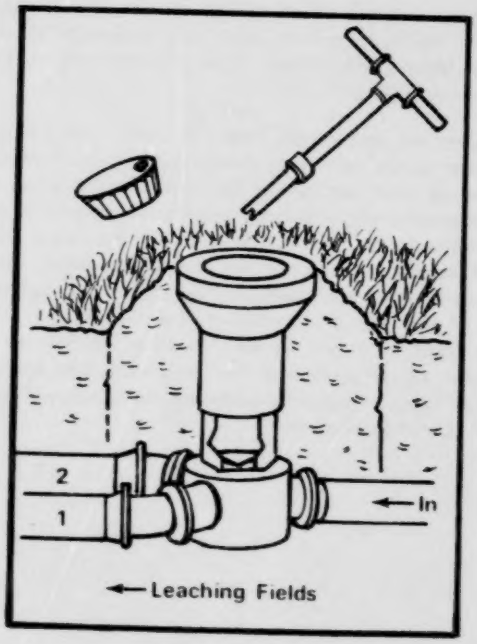

Figure 2. A Flow Diversion Valve with an External Regulatory Key

Source: Clayton, J.W., An Analysis of Septic Tank Survival Data from 1932 to 1972 in Fairfax County, Virginia which would be renewed every two years (5% or so of the tanks would overflow under a three year interval). To renew the permit, the householder would have to pay a permit fee and present proof of inspection and, if necessary, pumping. The inspection would be done by a licensed pumper, who would be required to pump the tank if sludge and scum were over 1/3 of the total tank volume, and to dispose of the pumpings in the community treatment site. Performance bonds and quality control would ensure that the pumpers provided satisfactory service.

Either the public or the regulated private approach could reduce many of the maintenance and performance problems of existing on-site systems. When combined with attempts to provide careful design and installation, low-cost techniques like pressure sewers to redeem old failures, and public ownership options qualifying for Federal grants, a system of on-site waste treatment could be set up which would provide excellent treatment at low cost.

There are missing factors, however. We have never been able to develop a program of operations and maintenance which is truly effective in the wastewater area, and will be working under the current lack of consistent regulation, which blocks innovation and supports variable performance. Money and support from EPA will help, but may not be sufficient.

Over the past several years, we have come full circle. Failing septic tank systems caused a great increase in sewering, and led to the belief that septic tanks were unacceptable and sewers were the only answer, a view still common in the profession. Now, we may have learned that sewers are not always acceptable, either environmentally or economically, and we are again suggesting the use of on-site systems. However, if we do not worry about the O&M, or if we decide that on-site systems are the answer, we will be back in five years doing it all again. The only "answer" is good engineering and good implementation, and that takes work.

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O & M COSTS OF WASTEWATER TREATMENT PLANTS

James L. Gamble[*]

PREFACE

To step from private life into public life as an elected official of a small town is quite a learning experience. Indeed, my training began very early.

Just a few weeks after I had been sworn into office, I arrived home one cold snowy January evening to be told by my wife that the Town Marshall was not only the Town Marshall, but the Water Commissioner, Street Commissioner, Director of Parks and Recreation, and our only full time employee. Today, the situation has only improved slightly.

It didn't take me long to find him because in a town of only 569 people, one can't stay lost for a long period of time. He told me rather abruptly that a water main had broken and he needed help. We drove to the location of a broken main and he handed me a pick, marked off a spot in the middle of the street and said, "the shut off for this section has been paved over and needs to be uncovered."

So I began digging into the asphalt. My hands became blistered, my feet got cold, and my back ached, but I dug until the shut off was unconvered. I must confess that as I dug, I wondered what I had gotten myself into! But I learned some pretty important lessons, the first being, that you don't pave over shut offs.

More importantly, I learned that a local official lives not only close to the people he serves, but close to the services he provides. They can and do have a direct influence on his life. Since then, I have been submerged in water past my hips repairing broken water lines, loaded trash, spent the night patrolling, chased strayed animals, including large, stubborn, and smelly sheep, and a thousand other tasks too numerous to mention. Fortunately, it hasn't been necessary to dig up any more streets by hand! But of all the tasks I have been asked to perform, none has been as frustrating and defies resolution more than the construction and operation of our wastewater treatment system.

INTRODUCTION

It is necessary when we discuss the operation and maintenance of Whitestown's wastewater treatment system to include in that discussion, the original capital investment of the community and the financial ability of the community to bear that capital investment. It has been our experience that only when the interaction of these factors are taken into account can the community successfully operate and maintain a treatment system. Unfortunately, these considerations were not made and the result is a treatment system that is an administrative problem.

It should be noted at the outset of this report that it is not intended to ignore the fact that Whitestown desperately needed a wastewater management system. Indeed, during the 1971 municipal election, the slate of candidates, of which I was a part, advocated the hasty construction of sewers and a treatment system. It should also be noted that that slate of candidates was elected by a substantial majority; therefore, we can assume that the residents also recognized the need and were willing to accept the additional cost of a monthly sewer bill.

However, it can be said, without fear of contradiction, that a pro-construction slate today would undoubtedly be defeated. What originally appeared to be a popular proposal became extremely unpopular and today is considered a burden by most of the residents. Moreover, as we, the administrators of the system, attempt to moderate this burden, the management of the system becomes an increasingly difficult problem. The demand of debt service requires that operation and maintenance costs be held to a minimum, so that other necessities may be purchased. In developing this report, let us first examine the resources of the town.

HISTORY OF WHITESTOWN

Local historians disagree about Whitestown's origins. However, the explanation that has the most credence is rooted deeply in American traditions — railroad and land speculation. I tend toward this notion for the following reasons. First of all, it is readily apparent that Worth Township, in which Whitestown lies, was created by removing parcels of land from four other townships. Secondly, this new township was named Worth, a name shared by the secretary-treasurer of the railroad. Thirdly, Alexander White was president of the railroad and just happened to be a Congressman when Whitestown applied for a post office. It goes without saying that their application was satisfactorily processed. Finally, there is some evidence that a site along Eagle Creek was abandoned not long after the town was founded. Even though the historians disagree about the town's origins, they do agree that Whitestown's early success was as a railroad shipping and receiving center serving an extremely productive agricultural community and some industry.

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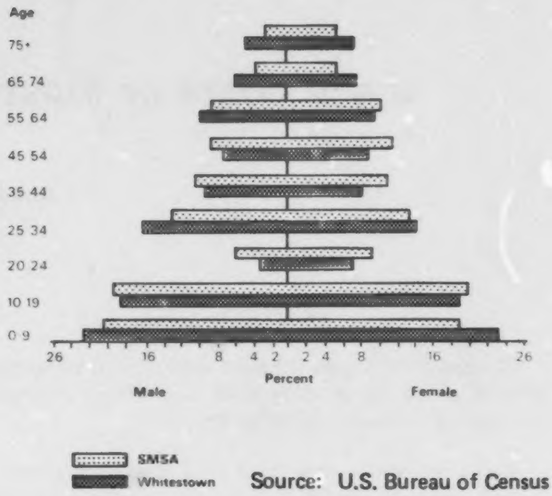
President of the Town Board
Whitestown, Ind.

As the use of the railroad began to decline in the late 1940's and early 50's and the family farm gave way to the corporate farm, Whitestown's economy declined as well. During the 1960's, the school was removed by a consolidation. Businessmen began to move to other locations. The removal of these two services meant the loss of many of the amenities that justify the added taxes of living within the corporate limits. By 1970, buildings were empty and many houses vacant. By 1971, the town had become a discouraged hamlet of 569 people. A frequently suggested solution was that the town should disband or unincorporate and let the county provide whatever services were needed. It was in the midst of these trends that the Indiana Stream Pollution Control Board mandated all communities with a water works and no sewers to have a wastewater treatment system constructed by December 31, 1971.[1] Since Whitestown owned a water works, they were included in that mandate.

COMMUNITY RESOURCES

As can be seen in Figure 1, the costs of constructing a wastewater treatment system would be borne, for the most part, by persons who were, retired and living on a fixed income, a substantial number of whom were widows, or relatively new households with younger children. It can be reasonably assumed that neither group would feel capable of having a large portion of their income diverted from other necessities to wastewater treatment. Figure 1 compares the age-sex composition of Whitestown with the SMSA. The predominance of these groups at both ends of the scale can easily be seen.

The little old lady in tennis shoes with her Social Security check clutched tightly in her hand has been made famous by the social scientist. It is not quite the same, however, when one lives across the street, next door, and immediately behind you! Their problems become very real; indeed, very close. Keep in mind if you will, that the lady who lived behind me, a widow, received a Social Security check of slightly over seventy dollars a month. It might also be good to keep in mind, that this particular lady just happened to be my mother-in-law!



Source: U.S. Bureau of Census

Figure 1.* Age—Sex Composition, 1970

The reason for the predominance of these age groups in the population profile can probably be attributed to three reasons. As can be seen from Table 1, the prominent out-migration, not only for Whitestown, but for Boone County is in the 20-24 age group. These are the major job-hunting years when many migrate to larger cities for employment opportunites, as illustrated by the Marion County statistics.

A more important reason, however, is the availability of low and moderate priced housing. As can be seen in Table 2, the value of houses in Whitestown is predominantly between $5,000-$14,999. Rental units are, likewise, lower than the metropolitan averages, however, rental units are a very small portion of the total housing stock.

It can be suggested at this point that the remaining population falls into two general categories, 1) those who feel that they have no alternative to move elsewhere, (the retirees and widows would probably fall into this category, or, 2) persons in low or moderate income occupations, who could not afford amenities or those whose life style made them willing to sacrifice amenities to live in the "country."

Table 3 will bear out both these conclusions. The median family income in Census Track 8107 (the Census Tract in which Whitestown is located) is slightly lower than the county and SMSA median incomes. This lower

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*Since Census data was available only in this form, the age group categories are not consistent; therefore, not providing a totally accurate analysis.

Table 1. Migration Rate 1950-60 by Age Group

Age Group	Indiana	Boone County	Marion County
All Ages	1.4	3.6	5.5
0-4	0.8	7.3	-1.0
5-9	1.7	14.6	-0.5
10-14	2.6	6.7	3.1
15-19	2.3	-3.7	5.6
20-24	2.2	-14.1	25.8
25-29	7.1	3.6	39.0
30-34	3.1	18.8	17.1
35-39	0.7	2.5	4.2
40-44	0.9	6.0	2.7
45-49	1.8	3.5	4.8
50-54	1.0	1.7	4.0
55-59	0.3	7.5	2.1
60-64	-0.1	4.6	-0.8
65-69	-3.3	-3.2	-3.8
70-74	-2.1	-0.3	-3.8
75+	-4.1	-6.6	-2.5

Source: Net Migration of the Population, 1950-60, USDA, Economic Research Service, Vol. I, Part 2

Table 2. Selected Financial Data

Characteristic	Whitestown		Remainder Worth Twp.	
	Units	Pct. of Stock	Units	Pct. of Stock
Total owner-occupied reporting value	124	100%	117	100%
Value of owner-occupied less than $5,000	16	12.9	1	0.9
$5,000 - 9,999	47	38.0	9	7.7
10,000 - 14,999	33	26.6	43	36.6
15,000 - 19,999	22	17.7	32	27.5
20,000 - 24,999	5	4.0	21	17.9
25,000 - 34,999	1	0.8	7	6.0
35,000 - 49,999	0	0.0	2	1.7
50,000 +	0	0.0	2	1.7
Total renter-occupied	47	100%	13	100%
less than $40/mo.	3	6.4	0	0.0
$ 40 - 59	7	15.0	6	46.2
60 - 79	15	31.9	5	38.5
80 - 99	6	12.8	2	15.3
100 - 119	2	4.2	0	0.0
120 +	0	0.0	0	0.0
No cash rent	13	27.6	0	0.0
Not reported	1	2.1	0	0.0

Source: U.S. Census of the Population, 1970 median income reflects the predominant rural population, however, with a large enough urban community to bring the median well above the U.S. rural median income. It should be noted, however, that these data are for the census tract which would include Worth Township. Since Table 2 indicated that the value of houses is slightly higher than in Whitestown, it can be concluded that those seeking a "country life style" would be found in the Township while those seeking low and moderate priced housing would locate in the Town.

Table 3. Median Family Income in 1970

Area	Income
U.S. Total	$9,590
U.S. Rural	8,071
Indianapolis SMSA	9,109
Boone County	8,944
C.T. 8107	8,828

Source: U.S. Census of the Population: 1970, Indianapolis SMSA, Table P-4 Income Characteristics

In Tables 4 and 5, we see the conclusions supported further. In Table 4, we see that the percentage of professional-technical and manager-administrator employees is considerably lower than the metropolitan percentage. The proportion of farm workers is approximately eight times the metropolitan area proportion. Moreover, the relative youth of the population suggests that many are just beginning their careers; therefore, not having accumulated enough seniority or education to ascend to manager-administrator levels. It would also suggest that income and employment would be easily influenced by fluctuations in the economy. Whitestown is receiving Title II Public Works funds, under the anti-recessionary funds and is eligible for other areas of public works funding.

As can be seen from the data that even if the residents of Whitestown were willing to contribute a large portion of their income for wastewater treatment, it would have been difficult for them to do so. Moreover, we can safely assume that the other necessities required by a young family, or a fixed income household, would probably receive higher priority. Let us now examine how much the treatment facility costs.

Table 4. Occupational Characteristics

Occupation	Percent of Employed Persons Over 16	
	SMSA	C.T. 8107
Professional, Technical	14.0%	6.3%
Managers, Administrators	8.7	6.0
Sales	7.7	6.6
Clerical	19.8	16.2
Craftsman	14.2	16.2
Operatives	14.7	16.5
Transport Operatives	3.9	6.6
Laborers	3.8	2.6
Farm Workers	1.4	10.6
Service Workers	10.7	10.8
Private Household Workers	1.1	1.6
Unemployed	3.2	1.5

Source: U.S. Census of the Population: 1970, Indianapolis SMSA, Table P-3; Labor Force Characteristics

Table 5. Educational Achievement 1970 — All Persons 25 Years and Over

Achievement	U.S.	SMSA	Tract 8107
0 years completed	1.6%	0.6%	0.5%
1-8 years	26.6	22.4	26.8
9-12 years	50.9	56.3	63.1
13 + years	20.9	20.7	9.6
High School Graduates	50.3	56.0	53.1
Median School yrs. completed	12.1 yrs.	12.2 yrs.	12.1 yrs.

Source: U.S. Census of the Population: 1970, Indianapolis SMSA, Table P-2 Social Characteristics

HISTORY OF THE PROJECT

On January 16, 1968, the Town of Whitestown submitted a proposal to the Indiana Stream Pollution Control Board.[2] The total cost of the project was estimated at $370,200. It included sewers for the entire town and a waste stabilization pond. Apparently the town felt the cost prohibitive and failed to follow up on this proposal. On October 1, 1970, the Town Board authorized an application for a grant to construct a sewage treatment facility to be completed by July 1, 1972.[3]

In the meantime, the Indiana Stream Pollution Control Board had revised its standards to require that communities that discharge into a stream with a 7-day, one-in-10-year low flow of less than two times plant design flow, would be required to install advanced waste treatment capable of removing 97.5 percent carbonaceous BOD_5. They had further determined that facilities discharging within forty miles of an impoundment, must provide 80 percent removal of the total phosphorus entering the plant, and if within forty miles upstream of a public water supply, then the effluent must be disinfected throughout the entire year.[4] Since all of these requirements were applicable to Whitestown, a new design was needed.

By December, 1971, the 569 residents of Whitestown had become one of the State's worst polluters. We were rated tenth on the priority point rating.[5] However, by this time a new proposal had been completed. This proposal called for mechanical extended aeration, with chlorination and advanced treatment. It had a capacity of eighty-five thousand gallons per day and the effluent to be 200 mg/l BOD. Of course the higher level of sophistication had a higher cost. An increase from $370,200 to $546,000 – slightly over half a million.

At this time, people became concerned; however, with State and Federal assistance we were assured the cost would be in the area of $6.00 per month, certainly under $10.00 per month. We were told, informally, however, that the standard would be met even if the cost rose to thirty dollars per month. For a while it seemed that the cost might reach that figure. The cost finally stabilized at $618,000[6] or just slightly over the assessed value of the entire town! That unique situation caused us to be on the wrong end of an April Fool's Day joke. The newspaper in a neighboring community announced that Whitestown had been condemned to become a penitentiary! The rationale was that it would be less expensive for the State to purchase the town than to construct a treatment facility! Of the total cost of $618,000, $215,560 was eligible for State and Federal assistance. The local share was $466,000.[7]

The Town Board proposed to raise the local share through a revenue bond with the Farmer's Home Administration at five percent interest per year. The cost per household was $12.00 per month as a minimum with an average combined water and sewer bill of slightly over $30.00 per month.[8]

Unfortunately, billing had to begin when the bond was issued, meaning we began paying for the service a year before it was provided. This was necessary to meet the first year interest. Needless to say, I avoided my mother-in-law.

Table 6. Whitestown Water Rate Increase Approved by State Public Service Commission, September 1975

Gallons	Water	Sewer	Tax	Bill	Delq. Chg.
1,000	$ 6.22	$12.00	$.25	$18.47	$.31
2,000	6.22	12.00	.25	18.47	.31
3,000	7.26	14.00	.29	21.55	.42
4,000	8.30	16.00	.33	24.63	.45
5,000	9.34	18.00	.37	27.71	.49
6,000	10.38	20.00	.42	30.80	.52
7,000	11.42	22.00	.46	33.88	.55
8,000	12.46	24.00	.50	36.96	.58
9,000	13.50	26.00	.54	40.04	.61
10,000	14.54	28.00	.58	43.12	.64

Water Charges

1st & 2nd 1,000 gal.	@$3.11 each 1,000
Next 8,000 gal.	@ 1.04 each 1,000
Next 10,000 gal.	@ .93 each 1,000
Next 30,000 gal.	@ .83 each 1,000
Next 50,000 gal.	@ .73 each 1,000

Sewer Charges

1st & 2nd 1,000 gal.	@$6.00 each 1,000
Next 8, 000 gal.	@ 2.00 each 1,000
Next 10,000 gal.	@ 1.80 each 1,000
Next 30,000 gal.	@ 1.60 each 1,000
Next 50,000 gal.	@ 1.40 each 1,000

THE RESPONSE OF THE COMMUNITY

What had begun as a well supported project was now opposed by a rather large and vocal majority at the rate hearing. Many novel suggestions were made, and some that were not so novel. Once again, unincorporating was proposed. Interestingly enough, this would have solved the problem, because Indiana Law prevents a county from building sewers and treatment plants, unless the citizens, through their township government, petition for a sewer district. This obviously wasn't going to happen. Indeed, at this time a neighboring county has been trying to deal with a very severe health problem in this manner, but due to citizen opposition, has been unable to do so.

The resistance to the project continues today. Indeed, in one instance the town was forced to exercise its police powers and hook one person's property into the system and file a mechanics lien against his property to recover the cost. This extreme measure was used because the proper depth of the interceptor was in question and the last of the funds could not be released until the question was resolved. In another instance, we had to file suit to mandate hook up, and in yet another, we provided a zero interest loan. For one old gentleman, whose only source of income is welfare, and who has been using a facility constructed in his back yard by the WPA, we sought and obtained a Community Development Grant to construct a modern facility. Unfortunately, he passed away before we could complete the grant. So we condemned the house and removed it.

THE PROJECT TODAY

In an atmosphere of hostility we completed construction. After four payments the bond has been reduced until we only owe $462,000. The system has yet to live up to its design standards, partially because of design oversights. Moreover, it was extremely difficult to find competent operators who could provide construction oversight for $2,000 a year. To get the system operating properly for the past year we have been helped by the City Engineer of a neighboring community and we hope to have all the kinks out of the system at the end of this summer.

The system continues to be a financial problem, however, operating costs were estimated at $40,017. Of this, $28,100 is required for debt service. Unfortunately, last year the operating costs were $44,120. A substantial portion of this increase was for electricity which last year totalled $6,950 and continues to rise. Indeed, last month it exceeded $1,000. Just to add to these problems, the utility only generated revenues totalling $38,457.[10] Since our other services could only best be described as token, and our General Fund budget just barely exceeds $15,000 it would appear that a rate increase is forthcoming. Which means, I will probably start avoiding my mother-in-law again, and probably many others!

THE FUTURE

The future doesn't look much brighter. The Stream Pollution Control Board is revising their standard and ammonia removal may have to be added. Estimated costs of this addition run from $1.00 to $2.00 per month more than the present rate.[11]

Since the system is operating at one quarter to one half capacity, more consumers would help relieve the situation. However, when potential developers get a look at our rate structure, they depart never to be seen again. Probably to build in a neighboring county on septic systems.

P.L. 92-500

The question must be asked: "Why didn't the town wait?" The increase in Federal activity through Public Law 92-500 was on the horizon. One year would have reduced the cost substantially. Indeed, the cost would have been reduced from $466,000 to probably less than $120,000. Because of several civil law suits, a neighboring community in Hancock County was required to wait. The result was, that the mandate stayed in effect. Under the priority rating their chances may be reduced; therefore, they are proceeding under the requirements of P.L. 660, rather than losing their present grant and starting anew. And that only after they were granted a special exception. We were assured that that is what would happen to us. The priority rating system would be changed and we would not be considered. Indeed, I must ask the question, "Was the problem that severe? Could something less sophisticated have been substituted?"

Finally, I must ask the question – is swimmable and fishable appropriate where swimming and fishing are not natural uses of the water, or should it be applied where those activities do take place; indeed, where they are possible? Are we protecting theoretical fish and theoretical swimmers? I don't raise those questions to challenge the standard, or to deny that Whitestown needed sewers, but that we do a better job of finding less expensive methods, less burdensome costs, less costly alternatives. After all, I still have to go home and face my mother-in-law.

FOOTNOTES

[1] Department of Metropolitan Development, Division of Planning and Zoning, Indianapolis-Marion County, Indiana. Water Quality Management Plan, Summary Report. May, 1973, p. 30.

[2] Clyde E. Williams and Associates, "Summary Final Plans and Specifications Sewers and Sewage Treatment Plant." Indiana State Board of Health Files. October 1, 1970.

[3] Minutes of the Board of Trustees, Civil Town of Whitestown.

[4] Department of Metropolitan Development. Water Quality Management Plan, Summary Report. p. 29.

[5] Clyde E. Williams and Associates, "Summary Final Plans and Specifications Sanitary Sewers and Wastewaters Treatment Plant, Whitestown, Indiana." Indiana State Board of Health Files, December 9, 1971.

[6] McCullough and Associates, Public Accountants, Letter, of March 29, 1976. Files, Civil Town of Whitestown.

[7] *Ibid.*

[8] Records Civil Town of Whitestown.

[9] McCullough and Associates, Letter of March 29, 1976.

[10] The Reporter, Lebanon, Indiana, January 20, 1977, p. 9.

[11] Indiana Heartland Coordinating Commission, Preliminary Report 208 Water Quality Study. January, 1977.

[12] Interview, Roger Bedard, A-95 Officer, Indiana Heartland Coordinating Commission. April 7, 1977.

Appendix

SEPTIC TANK MAINTENANCE PERMIT

As was the case for diversion valves and split fields, the mechanism by which a town may require and implement a septic tank maintenance program will vary considerably, depending on the existence and extent of other regulatory controls (at the State, county, and local level). In particular, the constitutional and "Home Rule" doctrines of a given State may raise rather complicated questions of a municipality's power to exercise a continuing regulatory function such as maintenance permitting. Again, for the purposes of this report, we assume that the town has concluded that the necessary authority and legal powers are available, and that it may lawfully implement and supervise a maintenance permit requirement.

If the town already has in place an effective and comprehensive sewerage disposal ordinance then maintenance permit requirements should probably be inserted in the appropriate sections of that ordinance. In the event that the municipality has no comprehensive sewer ordinance, virtually identical maintenance requirement language can be coupled with a statement of purpose to produce an ordinance which may be implemented independently. In either case, the following model should be helpful in guiding the ordinance drafters. Inclusion of the statement of purposes (bracketed) would depend on pre-existing ordinances. This material is drawn from the work of David E. Stewart, Small Scale Waste Management Project, Environmental Resources Unit, Madison, Wisconsin.

Model Section 1. Septic Tank Maintenance Permit – Purpose:

[It is recognized that proper maintenance of septic tanks will increase the useful life of all on-site sewage disposal systems which rely on soil absorption of septic tank effluent. To further the purpose of increased life of such on-site disposal systems, and to protect the health, safety and welfare of the inhabitants of the town of_______, the town of ______, hereby establishes a septic tank maintenance permit program.]

Section 2. Permit Required.

No owner may occupy, rent, lease, live in or reside in, either seasonally or permanently, any building, residence, or other structure serviced by a private domestic sewage treatment and disposal system; unless the owner has a valid septic tank maintenance permit for that system issued in his name by the________(sanitary inspector or zoning administrator). Owner is defined to mean a natural person, corporation, the State or any subdivision thereof.

Section 3. Fee.

A fee of $___ shall accompany each application for the septic tank maintenance permit.

Section 4. Permit Application.

Application for a septic tank maintenance permit shall be made to the_______(sanitary inspector or zoning administrator) on forms supplied by him. All applications shall state the owner's name and address, the address or location of the private sewage system and shall contain the following statement:

> "I certify that on___day of____, 19__, I inspected the septic tank located at the address stated on this application, and I (check one):
>
> – pumped all sludge and scum out of the septic tank, or
>
> – found that the volume of sludge and scum was less than 1/3 of the tank volume, and I did not pump the septic tank.
>
> ___________________________
> Signature
>
> ___________________________
> Sanitary License Number

Section 5. Issuance.

The________(sanitary inspector or zoning administrator) shall issue a permit to the applicant upon receipt of the fee and a completed application, properly signed by a person licensed to service septic tanks and stating his sanitary license number. The permit shall include on its face all information contained in the application and shall contain the date of issuance.

Section 6. Validity.

The permit issued under this section shall be valid for a period of two years from the date of issuance.

Section 7. Sale of Property.

When property containing a private domestic sewage system is sold the new property owner, prior to occupying, renting, leasing, or residing in the building, residence or structure served by the system, shall make application for and receive a septic tank maintenance permit; however, the system may be used for a period not to exceed 30 days after making application for a permit.

Note that this permitting structure assumes the existence of a licensed septic tank service firm. There is, of course, a potential for abuse or exploitation whenever a private owner's compliance with a permitting standard is based on the opinion or certification of a fee charging third party. In the absence of state licensing and regulatory control of the septic tank service firm, the town may wish to be rather creative in its efforts to ensure integrity in the permit process and protection of the interests of the owners. One approach would be for the town itself to assume licensing or regulatory control over the service. This alternative may, however, encounter very serious constitutional or restraint of trade problems, depending on the State involved. An alternative would be for the State to assume licensing and regulatory powers. In either case, the model ordinance, code, or statutory language to accomplish licensing would be as follows (the material is again drawn from the Stewart paper):

> Licensing: (a) License; application; fee. Every person before engaging in the business of servicing septic tanks, seepage pits, grease traps or privies in this State (municipality) shall make application on forms prepared by the________(department of licensing) of each vehicle used by him in such business. The annual license fee is $25 for each vehicle for a State resident licensee and $50 for a nonresident licensee. If the________(department), after investigation, is satisfied that the applicant has the qualifications, experience, and equipment to perform the services in a manner not detrimental to public health it shall issue the license, provided a surety bond has been executed. The license fee shall accompany all applications. The________(department) shall maintain a list of all those licensed under this section and shall make the list available to all interested persons.

The "Qualifications, experience, and equipment" should be defined to include an acceptable septage disposal site, of course.

As a third alternative, the town could create a department charged with the duty of regularly checking private septic systems, and given the power to contract directly with private service firms to pump septic tanks when necessary. The cost of pumping would then be assessed against the property owner. This approach would assure that pumping occurred when, and only when, it was necessary. However, it might raise fiscal problems for the town; more importantly, it might lead to problems related to a town's power to contract with private parties to have work performed. A legal opinion should be received early in such planning.

DIVERSION VALVES AND ALTERNATING FIELDS

The mechanism whereby a town may require that diversion valves and split fields be included in new sewage disposal systems will vary considerably, depending on the present nature of on-site sewage system regulations in the town. In many instances, only minor revisions of existing codes or ordinances will be necessary to include the new structural requirements. In other situations, where existing regulation is either weak or non-existent, the town may be forced to implement an elaborate set of controls in order to incorporate the suggested design standards. In either case, the town or municipality must be certain that the new standards can be mandated in a manner which is consistent with any overriding State or county powers. Thus, depending on existing laws and enabling legislation, it may be necessary in some States to implement the design criteria at a government level other than the municipality.

For the purposes of this report, we assume that the town has the necessary statutory and constitutional power to implement the suggested design criteria without further State or county involvement or authorization. The primary issue facing town officials will, therefore, be the manner in which the design change requirements are implemented. If the town possesses, in place, an elaborate or comprehensive set of standards for the construction of on-site sewage systems, a slight amendment to those standards should suffice. The following language is, therefore, designed to be added to existing ordinance specifications for sewage systems. The material has been taken, with minor revisions, from the Fairfax County, Virginia, Code for Sewers and Sewage Disposal.

Section 1. General Requirements for Composition of Individual Sewage Disposal Systems.

All individual sewage disposal systems installed or repaired shall consist of the following:

(a) Building sewer
(b) Septic tank
(c) Diversion Valve
(d) Distribution boxes
(e) Distribution sewers
(f) Soil absorption system of herinafter specified materials.

Section 2. Specifications and Location of Approved Building Sewers.

[Incorporate existing municipal regulations or standards.]

Section 3. Septic Tank Specifications.

[Incorporate existing municipal regulations or standards.]

Section 4. Specifications and Location of Diversion Valve.

(a) There shall be a diversion valve located in the four inch (or larger) pipe between the septic tank (or aerobic tank) and the distribution boxes. The diversion valve shall be a three-port, two-way valve of approved materials (i.e., resistant to sewage and leak-proof and designed so that the effluent from the tank can be directed to flow into either one of two distribution boxes).

(1) There shall be a manhole from the top of the valve to the ground surface with an appropriate cover to be level with the ground surface.
(2) There shall be provided a handle of proper length, designed so that the valve can be turned above the ground surface.

(b) In lieu of the aforementioned diversion valve any system that can be designed and constructed to conveniently direct the flow of effluent from the tank into either one of two distribution boxes may be approved if plans are submitted to the [Health Director] and he is satisfied that such system is satisfactory.

Section 5. Specification for Distribution Boxes and Watertight Lateral Lines.

[Incorporate existing municipal regulations or standards.]

Section 6. Subsurface Disposal Fields.

[Incorporate existing municipal regulations or standards in such a way as to provide for split fields of adequate size and capacity.]

Where a comprehensive set of on-site sewerage systems controls or design criteria do not exist, the municipality may need to draft and implement a somewhat elaborate sewage disposal ordinance in order to mandate diversion valves and split fields. Naturally, the elements of such an ordinance will vary considerably from town to town and State to State, depending on the contents and coverage of existing sanitary or health codes (State or local) and applicable State or county regulations.

OPPORTUNITIES FOR USE OF INNOVATIVE CONCEPTS

*Theodore C. Williams**

Small communities – communities under 10,000 population offer a virtual plethora of opportunites for innovative solutions to problems. In the first place, 80% or more of the EPA funded wastewater treatment projects are for towns of less than 10,000. In the second place, the smaller communities generally have fewer preconceived notions and are less skeptical about what will work and what won't work. While in large communities, there is too much inertia, too much experience and too much knowledge to gain the acceptance of significantly new ideas. Thirdly, many of these small communites are starting from scratch, and there are no existing facilities of any consequence that have to be incorporated into the design; so you do have a modicum of freedom which is not available in larger communities with existing treatment facilities.

Hundreds of smaller communities are undertaking projects. As a result, the stage has been set for advancements and improvements. We have both the opportunity and the obligation to develop innovative methods. We must be willing to make new mistakes. From an idealistic standpoint, this is commendable. But we must also consider the increased responsibility and the existence of some very real obstacles.

It's not easy to be innovative. It's like going off alone into the wilderness and it's easy to get lost. There are lots of wild animals and insects – things that are frightening. There are little things like mosquitos – these are the EPA audit staff. They are a nuisance and they are distracting. You get so busy slapping at the little buggers that you can't keep your mind on your job. And then there are snakes. The snakes are the program guidance memoranda, the program requirements memoranda. These little pieces of paper that sneak up on you after you have something almost done and they bite you right in the leg and you didn't even know they were there because they're not published in the Federal Register. No, they are just kept in the regional offices until they are needed to stop something from happening. You can start down a path and there is a big rhinoceros standing in the way –it's the rules and the regulations. It's hard to get a rhinoceros to move. They have a thick hide and they are very big. If you get him mad at you, he'll chase you right out of the forest.

And then there are the parrots that distract you. They repeat EPA regulations (or what they think the EPA regulations are) even though they are not appropriate in the circumstances. Another animal is the bear. Now a bear is generally quite peaceful and they are rather like our clients. They are very peaceful and they go along and they do their own thing unless they are aroused, upset, irritated and then there's no logic – and then they will tear you apart – they will claw you and they will kill you. Then there are the wolverines. The wolverine is an interesting animal and there aren't many of them left. Wolverines will kill more than they can eat. They will eat whatever they want from a carcass, but then instead of leaving it for someone else, they will urinate on it – spoil it so no one else can eat it. This is rather like some of our consulting engineers – they take more than they can do and then they spoil it – and it takes a long time for a small community to recover from this sort of thing. I could go on about the animals, and the insects and so forth in the woods, but you get my point and then my imagination has, perhaps, already been strained.

In spite of all of these things, progress has been made. Someone once said, "You never realize how far you have come until you look back." And that's true, you know. Progress has been made. There have been innovative solutions to problems. There are a lot of projects of which we, the engineering community, can be proud.

As I look down through the topics for discussion for these two days, I find that we, in our own office, have completed projects using almost all of these methods. We did the first pond spray irrigation system in the State of Michigan. We did the first pressure sewer system in Michigan. We did the first rotating biological surface treatment system in Michigan. We did the first system of aerated lagoons followed by chemical precipitation in Michigan. We initiated the action to make the spacing between manholes 600 ft. instead of 300 ft. We have the first marshland effluent irrigation system in Michigan. We have the first use of polyethylene pipe for force main in Michigan. We had the first use of chemical oxidation of sludge in Michigan. We have designed more land treatment schemes than anyone else in the country.

---

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We have come a long way, but we have a long way to go and there have been obstacles in developing these innovations. Some of them minor – some of them major. But if innovation, if accomplishment, if achievement, and professional satisfaction are really important to use, we will figure out a way to overcome hindrances.

Just as an example, consider the project for which we just received one of the Consulting Engineers Council's national awards. It's a simple thing where we achieve tertiary treatment of the effluent from a lagoon system by spreading it into a somewhat nutrient deficient marshland. We decided that there would be some mutual benefits. The community would save significantly in construction costs and in operating costs, and the nutrients and the effluent would serve to replenish the marsh, and improve its productivity. The marsh would be able to grow more ducklings per acre. We presented our case to the State regulatory agency and were told that it was a new concept and they would have to have much more information before they could approve it. The State water people wanted us to put the effluent on the land; the State land people wanted us to put it in the water. None of the regulatory agencies wanted us to put it in the marsh because that had never been done before.

A University of Michigan professor heard our presentation to the State and thought the idea had merit. He obtained a National Science Foundation Grant to study the concept and to analyze the impact of the project. After a three-year research program, we are now finally into Step 2 and have been able to obtain approval for the use of this method in that one location.

The system will actually be in operation in 1978. We first presented the idea in 1971.

We were fortunate that the system could be built in stages. If that had not been the case, we would have had to abandon the concept and the million dollar savings would have been lost. And, even more to my point today, if we had had to obtain that design contract on the basis of the low bid, we never would have taken the time to work with such an idea. The correspondence file on the project includes 162 letters just to get the idea approved.

That's just one example. And it is characteristic of all these kinds of innovative solutions to problems. Obtaining approval to use innovations and new techniques has required hundreds of man-hours, stacks of correspondence, a myriad of phone calls and scores of meetings. The end result of these innovations, of course, is the advancement of the art, the reduction of the cost of the project to the client, and if engineering fees are based upon the percentage of the construction, it would result in a reduction in our fee. But then that's why engineering is a profession.

There are few things in the world that approach the sense of accomplishment that comes from having an idea that will possibly do the job as well, or maybe even better, than any other way and still save the client money. Every savings on a system for a small community is especially significant because the cost is divided amongst fewer customers. Any change has a greater impact on the individual customer. This points up again the difference in perspective that applies to small communities, and I believe that perspective is important. For example, the EPA cost effective analysis doesn't always coincide with what is in the client's cost effectiveness analysis. We do both – we do an EPA cost effective analysis to present to the Federal establishment, but we also do a client cost effective analysis which is for our own use in our own office in deciding which alternatives are in the client's best interest. This is very important in small communities.

Operation and maintenance costs and particularly energy costs should, in my opinion, be given much greater weight in the cost effective analysis than they are. It doesn't do any good to build a magnificent facility if the community will not operate it. If by making some slight changes in design and some increased construction costs, perhaps we can make significant changes in operating costs, then I think this should be taken into consideration.

I've always thought that for a town of 1,000 or less a 30 or 40 acre facultative lagoon system that would provide about 2 years of retention of wastewater in a series of ponds would be the ideal facility. I can't justify it on the EPA cost effectiveness basis primarily because land for that type of a system is not grant eligible. But in terms of operating simplicity, operating costs, energy conservation – in terms of all of these things, it has to be the ideal solution for a small rural community. Grant programs will come and go and bond issues are paid off, but operation and maintenance costs go on forever.

Now, I want to do just a little arithmetic with you. Let's assume that the cost of operation and maintenance (no capital recovery) on a per million gallon basis could be any place between $150 per million gallons and $600 per million gallons depending upon the type of treatment that you design. This is a range that we see in small towns.

Assume the average residential customer with 3.5 persons per dwelling unit and a flow of 70 gallons per capita per day –

3.5 x 70 x 30 x 150/million gallons = $1.10/month
3.5 x 70 x 30 x 600/million gallons = $4.40/month

If this were a community with 833 customers, the difference is then not the difference between $1.10 and $4.40, but the difference is between $11,000 and $44,000 a year – or $33,000. Now for $33,000 a year, you ought to be able to spend some time thinking about how you can save that. It's worth some "thinking about" time. Now, I want to get paid for my "thinking about" time, and there has to be a mechanism by which people who have ideas that permit projects to be built with this much difference in annual operation and maintenance cost are rewarded for having the ideas and for doing things that are necessary to make it happen. There is no provision in the present procedures for this. There must be if less costly wastewater treatment is to be encouraged.

Now, let's do a little bit different arithmetic. Let's assume that power is 4¢ a kilowatt hour, and if you run a 10 hp electric motor continuously, all year, the electricity will cost over $2,500 per year. Assuming a 7%, 20 year bond issue, this would retire a local capital expenditure of over $26,000 – and with grants – from the local perspective only – over $100,000 in capital could be invested in construction to save operation of this 10 hp motor. That is cost effective in terms of the community.

If we can keep the O&M costs down and keep the energy requirements down, maybe we are doing the best job for the world – because lower O&M plus easier O&M equals better O&M.

The perspective again – what is our goal in this whole program? Our goal is to abate pollution; it is to ameliorate undesirable situations. It's not our goal to make it perfect. We're just trying to make it better. Rules, regulations, forms, audits – all of these things stand in the way of obtaining our goal which is to abate the pollution.

In order to achieve this goal – this goal of abating the pollution – consulting engineers must make a commitment to the development of creative, innovative, less expensive solutions to the problems. Government agencies must make a commitment to cooperation in expediting the program and react positively to new ideas. Too often we hear from consulting engineers and from regulatory agencies the response that begins, "Yes, but what if . . ." "What if . . ." I submit that the pursuit of asking the question, "Yes, but what if . . ." and the answering of the question becomes an indulgence and the result is a disservice to the very people we have taken an oath to serve.

There have been other problems having to do with the administration of Public Law 92-500. This would have been a monumental task even without the impoundment, but since the impoundment occurred, the results have been chaotic. The rules, regulations, interpretations have been the source of frustration and concern – to say nothing of those instances when State or Federal officials made speeches that included intemperate – even incorrect – generalizations about consulting engineers; engineers in turn have made generalized remarks about governmental officials and, as a result, an attitude of mistrust has surged into the adminstration of the program. The audit procedures which border on assumed guilt make it extremely difficult to function as a design professional. I am not advocating that any reprehensible situation be condoned. I am advocating mutual respect and reasonableness.

There are three things that I should like to see changed . . .

First, I should like to see the cost effectiveness analysis give more credit to energy – outside energy – requirements. Perhaps a multiplier of 3 for outside energy costs in the cost effectiveness evaluation would be appropriate.

The second change that I would like to see would be that land would be grant eligible for facultative pond systems. The present regulations read that land is eligible where it's part of the treatment process. If you make the ponds large enough, I suppose one could stretch the regulation somehow, but it would probably take a special memoranda from Washington.

The third change I would like to see would be that engineering Step 1 and Step 2 be removed from the list of grant eligible items so that the cost of engineering is paid for entirely by the local community up to the point of construction. It will remove the Federal establishment from its interference with the client/engineer relationships. It will permit the engineer to negotiate in whatever way he feels is appropriate with the owner and will permit more innovative designs to come forward.

I want to close with three quotations . . .

First, Cardinal Newman: "A man would do nothing if he waited until he could do it so well that no one would find fault with what he has done."

Second, Ralph Waldo Emerson: "Congratulate yourself if you have done something strange and extravagant and broken the monotony of a conventional age."

Third, Mark VanDoren: "Bring ideas in and entertain them royally for one of them may be the king."

PRESSURE SEWERS (WITH GLIDE/IDLEYLD CASE STUDY)

*Terry Bounds**

SUMMARY

This paper introduces the topic of pressure sewers with particular attention directed to the practice of pumping septic tank effluent.

Pressure sewer systems should be considered to serve areas where sewage collection by conventional means is impractical, uneconomical or otherwise infeasible. Often this concept provides the best alternative to individual on-site disposal as well.

Pressure sewers utilize small diameter PVC pipelines which are shallowly buried and resemble rural waterline installations. Pumps are used at each home or group of homes.

Sewage flows first from the home to the septic tank where floatable and settleable matter is retained and partially digested. The clarified effluent then flows into a vault where it is pumped into the main and conveyed to the plant for treatment. Figure 1 illustrates a simplified pressure sewer installation serving a single home.

OBJECTIVES

Perhaps you may someday be faced with the task of finding a means of alleviating sewerage problems in a small, semirural community which cannot economically be served by conventional sewers and has high groundwater and soils of predominately tight clay preventing satsifactory use of subsurface alternatives. This was the assignment undertaken by the Douglas County Special Projects Division late in 1973.

If this had been a strict farm area where homes were well separated there would have been comparatively little concern for health hazards. Instead, Glide, Oregon is a community where public contact with effluent from failing drainfields is of indisputable concern. A survey of the 500 homes involved revealed that 60% of the drainfields showed evidence of failure.[1] And as a result of this survey, a building moratorium was imposed rendering properties unsaleable though land use planning endorsed development of the area.

ALTERNATIVES

Numerous alternatives to the use of conventional drainfield disposal systems had been reviewed. Some were known to have merit, but required either discharge to waters or less restrictive soil and development conditions than those prevalent.

Discharge from numerous facilities was not favored nor was it allowed by regulatory authorities, while sites suitable for subsurface alternatives were generally distant from the homes to be served. Also, if a multiplicity of subsurface alternatives were used, surveillance and operational problems would be expected. Therefore, an overall sewer system was preferred.

Attention was then directed to previous engineering studies which had been prepared. Essentially, the conclusion presented in each study was that sewerage costs were beyond the financial capabilities of the area. Thus, conventional sewers were categorized as an infeasible consideration.

Further investigation of these sewerage studies revealed an interesting fact: the sewage treatment plant was estimated to represent only 9% of the project costs.[2] The remaining 91% was for the collection system. Why was the collection system so expensive?

The area is sparsely populated, resulting in long lengths of sewer line between homes. Also, being mountainous and rocky, the terrain presented many expensive obstacles for conventional sewers. It seems odd that areas such as this are often served by rural water systems, frequently without benefit of grant funds. Why then, do most of these rural communities seem to find it economically infeasible to collect the wastewater?

It is a general fact that exclusive of infiltration, wastewater flows would be less than water use due to uses not contributed to the sewer, such as lawn watering. Again, why was sewage collection cost so prohibitive while water supply was not? Considerations such as these dictated interest in pressure sewers.

PRELIMINARY RESEARCH

Literary searches performed by the American Society

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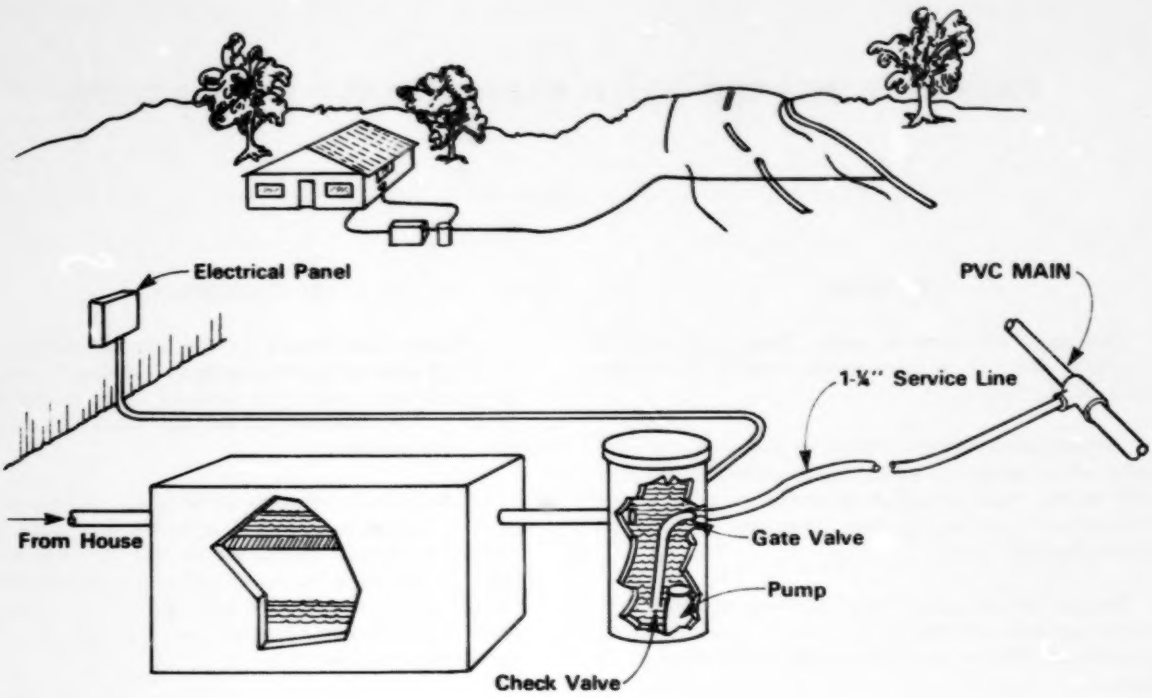

Figure 1. Pressure Sewer Service Connection Simplified

of Civil Engineers, Oregon State University, Water Pollution Control Federation, and others, resulted in the accumulation of over forty references. Correspondence was conducted with many of the authors and installations were inspected in Texas, Florida, Indiana, Idaho and Oregon. EPA officials were interviewed in Washington, D.C. and at the research laboratories in Cincinnati, Ohio. Also, the Farmers Home Administration was consulted.

The results of these investigations were encouraging. With strong public acceptance of the engineering report, design is presently underway to provide pressure sewers to serve the Glide, Oregon area.[1]

DESCRIPTION OF PRESSURE SEWERS

The basic elements of one type of pressure sewer are shown in Figure 1. Sewage from the home flows first to the septic tank where floating and settled matter is retained and partially digested. The effluent then flows to a vault where it is pumped into the main and conveyed to a disposal field or plant for treatment.

Septic Tank (Interceptor Tank)

Functions of the septic tank are several. Most importantly, it becomes an excellent trap for grit and grease. This benefits pumping substantially and eliminates many of the problems associated with the piping system.

A reserve space with a capacity exceeding one day's sewage flow is also provided within the tank between the normal top of the scum layer and roof of the tank. Should a pump malfunction, sewage flow from the home is not immediately interrupted. A high level alarm will alert the homeowner whose only inconvenience would be a telephone call to the maintenance office.

A secondary benefit provided by the septic tank is the degree of pretreatment achieved. Studies on the characteristics of septic tank effluent show that reductions of 50% to 60% for BOD and suspended solids may be expected with grease removals of 70% to 90%.[3] Of course, periodic disposal of septage from the tank must be accomplished.

The occasional carryover of light and filamentous solids may not be detrimental to the pressure system though this has not yet been fully demonstrated. This might indicate that septic tanks used on pressure sewers could be pumped less frequently than when subsurface disposal is used. The entire tank assembly including vault and appurtenances has been termed an "interceptor tank" by Rose.[4] This calls attention to the differences between a septic tank used in conjunction with subsurface disposal and a tank intended for use with pressure sewers, where there is capture of grease, grit, stringy material and the provision of reserve space (which is of primary importance).

Commonly, recommendations are to pump septic tanks at about two year intervals. However, a study on the subject of septic tank performance by Weibel, *et. al.* is interpreted to suggest that longer periods may be reasonable.[5] Experiences by Warren show indications that 500-gallon tanks used in conjunction with pressure sewers may need pumping at intervals of five years, or even less frequently.[6] Measurements by Schmidt indicate intervals of ten or more years to be adequate when 1,000-gallon tanks are used.[7]

Treatment means used by Warren and Schmidt do not employ subsurface disposal though they have not suggested whether the intervals would be shortened had this been the case.

In Douglas County, Oregon, the cost of having a tank cleaned is about $40. Though not negligible, the annual cost is seen to be small even if septage were required to be pumped from the tanks fairly often. Treatment and disposal of the septage may be accomplished in a variety of means and should be a matter included in pressure sewer proposals. No elaboration is given here as that subject is beyond the scope of this paper and is covered in other reports.[3,8,9,10]

Grinder Pumps

Some prefer the use of a grinder pump rather than a septic tank and effluent pump. These grind or cut solids within the sewage to reduce it to a slurry for pumping. However, grinder pumps are more costly than effluent pumps and quite often the entire installation is more expensive than an effluent pumping system, even when accounting for the cost of the septic tank.

Maintenance of a grinder pump is usually reported as being more frequent and more expensive, owing to the grinding function the pump must perform and the close tolerances common to this kind of pump. Grease is present in grinder systems, sometimes presenting problems with the controls. Also, the piping system design is more critical. Grease may accumulate on the crown of the pipe, reducing its capacity and interfering with the action of air release valves. Grease and grit within the piping system dictate that scouring velocities are required,[11] which is sometimes difficult to achieve.[12] Usually, grinder pump vaults are small, thus providing less reserve space than an interceptor tank. Accordingly, the need for prompt attention in event of failure is more critical.

For these reasons, effluent pumping has been selected as the preferred practice in the Glide, Oregon installation. In other installations, however, it may be important for the sewage to remain aerobic. In these instances, grinder pumps should certainly be considered. Evaluation should be made of the time the sewage remains in the vault and to residence time in the closed pipeline, as the sewage can soon become septic.

Effluent Pumps

One-third horsepower pumps are the most commonly used effluent pumps and usually cost about $150. However, the pumps must be selected based on hydraulic requirements and operating conditions, and may vary from one-fourth to two horsepower.[10, 11] The matter of simultaneous pumping from a number of installations to a common header (similar to pumping parallel) has been a topic of concern for many. Readers interested in this subject are referred to publications by Battelle and others.[11,12,13]

Traditionally, engineers have avoided pumping sewage whenever possible. There are important differences to be kept in mind when applying that rationale to pressure sewers:

1. Pressure sewer pumps may easily be remoed from the vault and replaced in minutes.
2. Reserve space provides sufficient safety margin to insure uninterrupted service at the home.
3. Grease, grit and stringy material are not present in the pump vault.
4. The pumps are inexpensive.
5. Enough pumps may be involved to justify district employment of a trained and efficient service repairman.

Those who have had limited experience with the pumping of septic tank effluent have a tendency to associate the practice with frustration, when in actuality the reasons for failure are boldly apparent upon careful examination. Typically, they are poorly constructed installations with improperly selected components.

In contrast, the pressure sewer pump installations by Schmidt[7] are an uncluttered and durable design, where maintenance functions can be performed without difficulty, and in minutes. All installations are identical, so parts may be exchanged if necessary, and maintenance functions are simplified. Because of proper maintenance and careful selection of components, the systems designed by Schmidt have had seven years of successful operation.

An installation in Priest Lake, Idaho, having about 500 effluent pumps in operation, experienced problems with 8% of the pumps during the first year of operation.[6] This figure dropped to less than 2% during the second year and maintenance personnel have anticipated even fewer difficulties in ensuing years.

For the pressure sewer concept to be successful, design excellence is a necessity. Equipment must be selected with great care and installed with the criteria that maintenance functions be made as simple as possible. This becomes a more difficult task than is apparent. Since the advent of pressure sewers is relatively new, suppliers and designers do not have the years of experience on which to rely.

Though most investigators of pressure sewers will be cautious of the need for excessive pump maintenance, well designed installations have proved to be easily maintainable at reasonable expense and a minimum of inconvenience. Readers interested in reviewing pump maintenance data are referred to work by Schmidt,[7] Durtschi,[14] Klaus,[15] and others, described in some detail in the Glide report,[1] wherein an assumption of $50 per year for pump operation and maintenance was adopted.

Service Line

The service line between the pump and main is usually 1-1/4-inches in size. Installation is easily accomplished with a trencher in contrast to the more difficult installation of conventional sewer laterals.

When sewerage is provided to existing dwellings, homeowners often find the plumbing outlet is oriented to the rear of the house where the septic tank is generally located. Consequently, to connect to a gravity sewer often requires that the house plumbing be reoriented, sometimes at substantial expense.

Mains

Sewer mains are PVC and resemble rural waterline installations. They are sized as dictated by hydraulic design,[11,12] but to describe order of magnitude, the following table may be used. Sizes and costs shown are approximations and should be used for only the most *cursory* of estimates. To illustrate how widely costs may vary, a recent installation in Texas[16] cost 90c per lineal foot for four-inch pipe as opposed to the $5 per foot estimated for the Glide area.

Size and Cost of Pressure Sewer Mains

Number of Homes Served	Size of Main[a] (dia., in.)	Cost of Main[b] ($/l.f.)
5	2	3
60	3	4
150	4	5
400	6	7

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[a] Pipe sizes have been reported using design flows proposed by Battelle[11] and assuming a velocity of 2.5 fps.

[b] Costs shown are those adopted for the Glide Study[1] where topographic difficulties are more extreme than average. Costs include furnishing and installing the pipe, fittings, valves, bedding, pressure sustaining devices, road crossings, pipe cleaning, pressure testing, engineering, etc.

Lack of extensive data will justifiably cause engineers apprehension with regard to determination of adequate pipe size. At present, there are but a few pressure sewer systems in operation, most sized for a future population. Consequently, pipe sizing may be as yet unrefined, especially with regard to larger systems which approach design figures.

The provision of reserve space within the interceptor tank, and the inherent characteristic that centrifugal pumps can operate at shutoff head periodically, provides a safety factor. Suppose a pump should turn on during a time when the pressure in the main is too great for the pump to discharge. Then the pump would run without discharging until the pressure in the main lowered. Normally this period would be brief and occasional. Meanwhile, service to the home would be uninterrupted due to the reserve space available. Unless flow from the home continued until the effluent reached the high level alarm sensor, this condition would not be known.

This feature is desirable, but not to the point that systems should be undersized with undue reliance on shutoff head operation and the use of reserve space.

Air Entrainment

Desirably, pressure sewers should be oriented such that flow is in the upslope direction,[11] i.e., the outfall should be at a higher elevation than any significant portion of the collection system. Should conditions require that pumping downslope is necessary, large quantities of air may enter the main which can result in hydraulic difficulties. Detrimental effects of air in pipelines are generally known and have been covered in papers by Lescovich[17] and others. The matter of flow in closed conduits on downgrade slopes where two-phase flow may occur is lesser known. However, a paper by Kent describes this condition.[18] To maintain a positive pressure in pipelines, several methods have been used, including the use of vertical stacks or pipe risers, and also special control valves. Readers are referred to work by Burton and Nelson,[19] Biggs[16] and Whitsett.[20]

As yet, the need for such control on pressure sewer systems awaits further demonstration, but recommendations by Battelle[11] and others[12] suggests that control to avoid two-phase flow and to prevent the entrance of air may well be required.

PRESSURE SEWER VS. CONVENTIONAL SEWERS

In areas where conventional sewers are economically attainable there may be little need to consider alternatives. However, pressure sewers may be feasible when conventional sewers are not. In areas of "difficult" terrain, certain advantages favor the use of pressure sewers and are recounted here for descriptive purposes.

Costs

Under favorable conditions, conventional gravity sewers may be installed at a cost of about $15 per lineal foot. In these cases and where homes are closely spaced, the conventional sewer is feasible and practical. However, if rock excavation is encountered, prices may rise to $50 or more per lineal foot. Another condition detrimental to the economic installation of gravity sewers would be the existence of high groundwater.

At one installation in Oregon the trench could not be dewatered even when using pumps capable of discharging several hundred gallons per minute. Once the pipe was installed, it suffered many breaks due to poor bedding. These breaks, of course, admitted great amounts of infiltration requiring expensive repair to the newly installed sewer.

Cost advantages may dictate the use of pressure sewers under far less extreme conditions than those just mentioned. Where construction within roadways is required, gravity sewer costs might average about $25 per lineal foot. Construction problems may also include the shoring of trench walls, the avoidance of culverts and buried utilities which sometimes require sewer depths to be increased, and springs which may be intercepted during trenching necessitating dewatering and many other factors.

When gravity flow in a conventional sewer cannot be continued due to topography or excessive sewer depths, lift stations are required. Though costs vary widely, the least expensive lift stations may cost about $15,000. These are infrequently required in areas conducive to gravity sewer collection, but in areas of difficult terrain where pressure sewers would be considered they may be frequently needed. In the Glide, Oregon study,[1] 19 lift stations would have been required had gravity sewers been used. In the pressure sewer proposal this number was reduced to three.

Pressure Sewers Combined with Gravity Sewers

When homes are located at an elevation substantially lower than the route a conventional sewer might follow, the required depth of sewer often becomes great with resulting high cost.

In the conventional sewer option of the Glide study,[1] 48 homes were planned to be served by pressure sewer connections into the gravity main because the homes were at such an elevation with respect to the main that gravity connections were totally infeasible. So pressure sewers can be advantageously applied in conjunction with gravity sewers.

Discussion

Compared to conventional sewers, pressure sewer piping is relatively inexpensive. This allows for sewerage service in extreme topographical conditions or where homes are widely spaced. Also, in using conventional sewers most of the investment must be made in the first stage of development. In contrast, pressure sewers offer a low cost infrastructure with the cost of the pump and interceptor tank being deferred until the home is built and connected to the main. This consideration becomes significant in slowly developing areas.

Infiltration is common to gravity sewers, often producing wet weather flow of five to ten times that of dry weather. As pressure sewers receive nearly negligible infiltration, a substantial benefit is gained. This must be considered when evaluating these two systems.

After all these factors are taken into account, a determination must be made: Will the cost of interceptor tank, pump, etc., and the maintenance required, outweigh the initial cost savings? This question cannot be answered in general; a particular setting must be evaluated. In the Glide study, a 20-year cost effective evaluation favored pressure sewers by a margin of two to one, as determined by present worth analysis.

While there are many differences to be acknowledged between conventional and pressure sewers, it is presumed the preceding has argued the point for pressure systems sufficiently to acquaint readers with some of the advantages, and perhaps the instances, where pressure techniques may be successfully applied.

It is not intended that pressure sewers replace or eliminate the use of gravity sewers. Certainly, in densely developed areas where topographic conditions are conducive to the construction of conventional sewers an evaluation of the two alternatives may well favor conventional. It is also difficult to evaluate pressure sewers as there are always unknown factors associated with a new concept. Only by experience can the performance of pressure sewers be forecast without some measure of anxiety.

PRESSURE SEWERS VS. ON-SITE DISPOSAL

There may be no better means than the use of a septic tank and drainfield for disposal of sewage in appropriate areas. Installed, costs in Oregon average $1,550,[1] operation and maintenance requirements are low, and the practice is environmentally sound. Septic tanks and drainfields are normally successful in rural or semirural areas where soils are conducive to subsurface disposal. Alternatives, then, may be suggested when the soils are not suitable for conventional disposal means. As a reasonable cross section, the following choices may be considered:

- Mound systems
- Sand filters
- Evapo-transpiration.

Mounds

The mound system may be used where soils are not suited to drainfield construction, but only in certain instances described by Otis, Bouma and other researchers at the University of Wisconsin.[22] They are rather large, requiring a suitable site of two to five thousand square feet,[23] which is not always available.

Mound systems are rather expensive with an average installation costing from $3,000 to $5,500.[23] Carefully executed construction is also required which is not as easily accomplished as might be idealized.

Operation and maintenance costs have not been estimated but the system requires the same septic tank and pump as does a pressure sewer system. Mound systems are an endorsed practice and in many areas a good and valid alternative. The choice between a mound system and effluent disposal in another manner will depend on the particular site being evaluated, but pressure sewer components will likely be used in either case.

Sand Filters

Sand filters exist in several designs, notably the intermittent sand filter under study by Otis,[23] Sauer,[24] *et. al.,* and the recirculating sand filter developed by Hines and Favreau.[25] These systems are reported to treat the waste very effectively, leaving the requirement of disposal. Again, there are options which include *(a)* disinfection and discharge to receiving waters, or *(b)* drainfield disposal.

When discharge to waters is employed, there is concern as to the reliability of treatment and of disinfection practices. Also, substantial space is required in addition to a septic tank and pump. Costs in Oregon for a single home are reported to be in the order of $3,000 to $4,000[26] which includes the drainfield required by the State.

Without the drainfield, costs have been estimated at about $2,000.[26] The sand filter alternative to subsurface disposal is thought to have considerable merit and is the system judged most promising by State of Oregon regulatory authorities. However, when serving individual homes, Oregon authorities do not endorse discharge to streams. This is largely due to surveillance problems. Pressure sewers would more likely be considered for groups of homes rather than for single homes. Sand filters may, in some instances, become the treatment method of pressure collected effluent. When a number of homes can be served, economy of scale can be realized and a responsible agency formed to insure proper operation and maintenance of the single treatment facility. The fact that treatment has been consolidated is of merit, and provides a more simple and effective monitoring program.

Evapo-transpiration

Evapo-transpiration systems are climate dependent, thus they are limited in application. Costs may vary widely, depending on the particular design employed, but those proposed for experimental use in Oregon are reported to cost from $3,000 to $7,500 when serving a single home.[27] These systems also require considerable space on the home-owner's property.

Discussion

In recent years considerable progress has been made in developing alternatives to conventional subsurface disposal with results that are highly respected. But the point of this discussion is that each alternative, whether subsurface disposal or conventional sewerage, requires proper application. A large gap exists between those choices, introducing pressure sewers.

PRESSURE SEWER GENERAL COST

Though there are numerous reasons for use of pressure sewers, economics play a major role. In the Glide study it was estimated that pressure sewers would cost each home-owner $1,925 initially and $9.50 per month for management, operation, and maintenance.[1] These costs are complete, including the treatment plant, interceptor tank and pump, mains and appurtenances. The capital cost per home is represented as follows:

Estimated Cost of Pressure Sewer System per Home
Glide, Oregon

Interceptor tank, pump, etc. (all work on homeowner's property)	$1,150
Collection system	475
Treatment plant	300
Total	$1,925

Nearly half of the $9.50 charge for operation and maintenance was represented by maintenance of the pump and interceptor tank. Conventional sewers, as previously noted, were estimated to cost homeowners about twice as much as determined by present worth analysis, using 6% interest and a 20-year period.

Where obstacles to conventional sewers are even more severe, the cost advantage for the use of pressure sewers widens. An installation in Priest Lake, Idaho serving 500 homes was constructed in 1974 at a reported initial cost of one-twelfth that estimated to provide conventional sewers.[14]

MAINTENANCE

It can be argued that the true cost of maintaining pressure sewers will only be known after many years of operating experience. While that is acknowledged, it is also difficult to estimate the cost of maintaining conventional sewers. Historical records from which one would compile statistical cost data have often been gathered from systems with excessive infiltration and inflow and where bypassing has occurred. Assuming that such practices are no longer acceptable, historical maintenance cost records are equally unsuitable for purposes of forecasting.

A similar situation is true regarding maintenance of septic tank-drainfield installations. Often, little or no maintenance is given to these systems but generally their performance has not been satisfactory. One of the factors leading to misconceptions about maintenance required of septic tank-drainfield installations is the lack of adequate records. Where surveys have been conducted, results frequently refute assumptions of satisfactory service.[28]

A basic choice confronts those proposing the use of pressure sewers: Should maintenance of the interceptor tank and pump be performed by the owner or by an established agency? Judging from the maintenance normally provided to septic tanks, owner maintenance is regarded as a risky venture. Also, a valid economic comparison of alternatives can only be made if the systems considered are approximately equal in ability to dispose of sewage without public nuisance or hazard to health. With these thoughts in mind, the Glide study recommended that maintenance be agency-provided. This justifies employment of a qualified service repairman and allows for the more economic purchase of materials and repair. Experience at other pressure sewer projects has indicated that pressure systems, when properly managed and maintained, will provide a quality of service generally comparable to that obtained from a conventional sewerage system.

TREATMENT AND DISPOSAL

Treatment and disposal may be accomplished by a variety of means. In the Glide, Oregon proposal, a lagoon followed by intermittent sand filters and irrigation disposal is presently under construction by regulatory authorities. Another alternative is the use of the extended aeration mode of activated sludge treatment with effluent polishing being accomplished by mixed media filtration.

If the number of homes to be served were small, a conventional subsurface drainfield (or alternative) might be used. The pressure concept could offer benefits:

1. The disposal site could be located distant from the homes in a select area.
2. Pressure distribution and dosing principles are often simplified.

In some cases an existing sewer may be close enough that pressure sewer effluent could be discharged into the sewer, but where topographic conditions might have rendered the extension of gravity sewers infeasible. In such cases consideration should be given to three factors:

1. Corrosion
2. Odor
3. Toxicity.

Conditions of concern include quantity of septic waste, quantity of receiving sewage, sewer pipe materials, and degree of turbulence. These subjects become a far too involved matter for discussion in an introductory paper. Interested readers are encouraged to refer to publications by Pomeroy.[29]

Treatment might be accomplished by a conventional or nearly conventional treatment plant.[3] Though discussion of this aspect is also beyond the purpose of this paper, some differences between pressure sewer waste and conventional sewage should be recognized:

1. Pressure sewer effluent is septic with potential for odors.
2. There is comparatively little history of treating septic tank effluent which would provide basis for design.

Very good results have been experienced by those treating septic tank effluent, but in large scale the experience is limited. For the reader's reference the following are listed:

Schmidt[7]	Activated Sludge
Durtschi[14]	Lagoon
Otis & Sauer[23,24]	Intermittent Sand Filter
Hines & Favreau[25]	Recirculating Sand Filter

Advantages to the treatment of pressure collected septic tank effluent are:

1. The waste has been pretreated in a clarifier (interceptor tank). Because of this a grit chamber, bar screen or comminuter would be redundant. The BOD and SS concentrations have been reduced by 50% or more,[3] and little grease is present. Because of the pretreatment provided by the septic tank, simple processes such as sand filters may be used when serving a small number of users.
2. Infiltration and inflow have been nearly eliminated.

In all, the practice of treating pressure collected septic tank effluent may require further demonstration, but appears promising. An important point to keep in mind is that the treatment and disposal of pressure sewer effluent may be accomplished by any of the methods used in both subsurface practice (or alternatives) and in the treatment of conventional sewage, though modifications may be desired.

SUMMARY AND CONCLUSIONS

Pressure sewers may advantageously be used:

1. When serving individual homes or groups of homes in conjunction with subsurface disposal techniques.
2. To convey wastewater to a receiving sewer.
3. As an alternative to conventional sewers.

Pressure sewers are particularly adaptable to serving rural or semirural communities where public contact with effluent from failing drainfields presents a substantial health concern.

Benefits are primarily economic, but may include better land use by enabling the development of areas difficult to serve otherwise. Bypasses and overflows common to conventional sewers are eliminated owing to negligible infiltration and inflow.

Design requires attention to detail in order to provide a properly functioning and easily maintainable system. Parameters are in the formative stage due to the newness of this concept.

It would seem prudent to encourage the construction of small systems which will acquaint designers with the concepts prior to undertaking more sizable commitments. It is incumbent upon designers of any new system such as this to strive for quality installations. Otherwise, the concept is likely to earn an undeserved poor reputation.

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FOUNTAIN RUN, KENTUCKY (CASE STUDY)

*Jack L. Abney**

SUMMARY

Public Law 92-500 contains provisions which, as some interpreted them, may allow for Federal funding of publicly-owned onsite wastewater treatment/disposal systems. Such systems would be required to meet the requirements of the Federal facilities planning process.

One small community in Kentucky seemed especially well suited for such consideration. Currently without a sewer system, preliminary cost estimates for conventional sewers and central treatment showed excessively high sewer bills would be required, even with 75 percent Federal assistance.

The experience of the consultant led to a system design of individual septic-tanks, effluent sewers and clustered subsurface disposal sites. The final preliminary plan includes 22 community subsurface disposal sites and a similar number of single-user disposal sites.

Monthly sewer bills required to support the two systems have a significant difference. The conventional system would require about $17 per month while the selected system would require about $7 per month.

OBJECTIVES

Fountain Run, Kentucky, is a small city which decided that reliance on individual sewage disposal was hindering development of the town. In 1976, a wastewater facilities plan was prepared under a grant from the U.S. Environmental Protection Agency as provided in Section 201 of Public Law 92-500. The objectives of this plan were as follows:

1. Provide adequate public wastewater management to serve the needs of the community through 1995.
2. Comply with stream quality standards and other environmental regulations.
3. Minimize total 20-year costs for achieving the previous two objectives.
4. Develop a plan of implementation.
5. Assess environmental effects of various alternative systems which could meet the first three objectives.

CHARACTERISTICS OF THE PLANNING AREA

The planning area includes one incorporated city, Fountain Run, and about 3 square miles of unincorporated land, all in Monroe County, Kentucky. Most of the area is served by the Fountain Run Water District. No major water-using industries are located within the area.

The plan was prepared under the authority of the Water District, with the city cooperating.

The total population was 436 in 1975, with 318 living in the city. Lot sizes are fairly large, with the average city lot covering about one acre. About 130 residential and commercial occupied structures existed within the city limits in 1975.

Households and businesses all utilized on-site disposal of wastewaters in 1976. Most had septic tanks but a few pit privys also were used. About 80 percent of existing wastewater sources were located on soils having good characteristics for subsurface disposal of wastewater. Major soil series include the Crider, Frederick and Trimble, which have USDA textural classifications ranging from silt loam to heavy silty clay loam.

The topography is rolling with some karst development. Underlying rocks are limestone and dolomite, with some interbedded shale.

WASTEWATER EFFLUENT STANDARDS

Any effluent discharging to a surface stream was required to meet fairly strict standards. Concentrations of key pollutants were not to exceed the following levels:

Five-day Biochemical Oxygen Demand: 10 mg/l;
Suspended Solids: 15 mg/l;
Ammonia Nitrogen: 1 mg/l;
Dissolved Oxygen: 8 mg/l.

ALTERNATIVE WASTEWATER MANAGEMENT SYSTEMS

In attempting to develop alternative systems, most of us are bound by our experiences, training and prejudices. One cannot usually consider an alternative that is not known or readily understood. Neither is a person likely to

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consider an alternative with which only negative experiences have been gained, unless forced to do so by regulatory or managerial edict.

Perhaps these are common reasons for not considering on-site disposal in engineering plans. But when a person has succeeded in breaking through the regulatory restraints against designing on-site disposal and has successfully designed systems on difficult sites, he is likely to consider this approach in future applications.

In 1965 the author was fortunate enough to be able to apply flexible design criteria for on-site disposal in a local Health Department in Indiana. Working from Federal Housing Administration studies of septic-tank systems and with the aid of soil scientists and a geologist, he was able to develop a set of design criteria for on-site disposal that worked in that county very well. A further opportunity was gained in 1969, when he became associated with an Environmental Demonstration Project in Southeastern Kentucky. In that project several demonstrations of improved on-site disposal systems were installed on sites which could not be approved under the State Plumbing Code.

The Appalachian Project also had prepared several preliminary engineering plans for community sewerage systems. These plans included fairly detailed costs for sewer line construction which showed clearly the exorbitant cost of conventional sewers. Table I shows an analysis of these costs, updated by means of the U.S. EPA sewer construction cost index.

In some of the proposed service areas, sewer construction alone would cost more than the median annual family income of the persons served. When compared to the costs for the on-site disposal systems we had devised, sewers could not be economically justified in most of the areas studied in Appalachian Kentucky. However, no regulatory, financial or managerial system existed which would permit the effective utilization of "engineered" on-site disposal systems.

Therefore, the Project could merely make recommendations for improvements in design of on-site disposal systems. These recommendations are contained in a report,[2] published shortly before the Demonstration was terminated.

In developing the Fountain Run plan, accepted Federal policy was followed and, initially, only conventional sewers and central treatment were considered. Various treatment alternatives were examined, with simplicity of operation a primary goal. The final treatment process selected was a 3-cell oxidation pond with land application of effluent. It was only after calculation of the average monthly bill that it was realized that the community probably could not afford such a system. Subsequent meetings with the local people confirmed that this conclusion was shared by community leaders.

Table 1. Appalachian Sewer Construction
(Costs Updated to March, 1976)

Type of Area	Users	Ave. Cost Per User	Max. Cost Per User
1. Rural	596	$7,960	11,350
2. Rural	136	6,190	19,180
3. Urban	2,025	5,970	26,280
4. Urban	73	5,730	12,420
5. Suburb	330	3,980	N/A
6. Urban	44	3,750	N/A
7. Suburb	335	3,470	5,240
All Above		$5,860	

With an assumed Federal grant of 75 percent and a low-interest loan for most of the remaining 25 percent, the average monthly sewer bill would be over $17. With no grant, the average bill would be over $30. At the time, grants were only available for treatment and so the higher figure would have been closer to reality.

Therefore, the consultants began to consider true alternatives to the familiar conventional sewers. The experimental sewer system installed at the Grady W. Taylor subdivision near Mt. Andrew, Alabama, served as initial inspiration for determining the cost of a similar system for Fountain Run. Further encouragement was given by recommendations developed by Paul Pate of Birmingham, Alabama, Department of Health. Both capital and operating costs were projected to be lower for this "effluent sewer" system, as it was called. But the average bill would still be high: about $13 per month.

It was then decided to divide the service area into smaller subareas and eliminate the central treatment facilities, while utilizing effluent sewers and subsurface disposal. This approach required a careful evaluation of the location of soils most suited to subsurface disposal and the identification of soil factors which might restrict their use for sewage disposal. Unit costs were developed for septic tanks, dosing devices, effluent sewers and disposal systems. Several trial-and-error combinations of users were tried before settling on a reasonably efficient arrangement. The final system consisted of 22 "community" systems having 2 or more users on shared disposal fields, plus 22 on-site disposal systems.

The cost for this "community subsurface disposal system" was significantly lower than the two previous systems. The average bill was estimated to be $7.30 per month, with 144 customers contributing. A further plus was the fact that an additional 24 customers were included.

As a final consideration, the cost for total on-site disposal with public management was analyzed. The same

144 customers were assumed to require replacement of their disposal system with new, "engineered", systems. Standard absorption systems were estimated to cost $12,000, while special designs required to overcome soil limitations were estimated to average $1800 each.

The costs for the total on-site plan would be lower than costs for the community system. Average monthly billings would be about $5.70 with 75 percent Federal assistance on construction costs.

ALTERNATIVES ANALYSIS

Table II summarizes the main features of these four alternate wastewater systems. Total construction costs, including engineering, for these alternatives are shown on Figure I. Alternate "A" would require $524,400, "B" would require $367,500, "C" would require $340,200 and "D" would require $247,000. Conventional sewerage system "A" would cost more than twice as much as on-site disposal "D", and 1.54 times as much as the community subsurface system "C". This resulted even though a much greater cost for engineering and contingencies was included in "C" and "D" than in "A". A rate of 20 percent was allowed in "A", while 30 percent was allowed in "C" and "D" for engineering.

Table II. Alternative Systems

A. Central System:

Conventional Sewers
Oxidation Pond
Infiltration-Percolation

B. Central System:

Effluent Sewers
Oxidation Pond
Infiltration-Percolation

C. Decentralized System:

Effluent Sewers
Subsurface Disposal

D. On-Site Systems:

Septic Tank
Subsurface Disposal

Annual funds required for operation, maintenance, billing and debt service are shown in Figure II. Even though 20 percent fewer users are included in Alternate "A", it would require 2.3 times as many annual dollars as "D" and 1.8 times as many as "C".

Figure III illustrates the relationship in present worth for the four alternates. This comparison is the one mandated in the "201" planning guidelines. Present worth is a composite of initial capital, a lump sum to provide operation and maintenance for 20 years, and an allowance made for any salvage value at the end of the 20 year period. Relationships are similar to those in the preceding graphs, but not identical.

The economic comparison which matters most to the local citizen is the monthly bill for services. Due to the effect of Federal funding, and the varying service population the relative difference in the four alternatives is greater than in any other comparison.

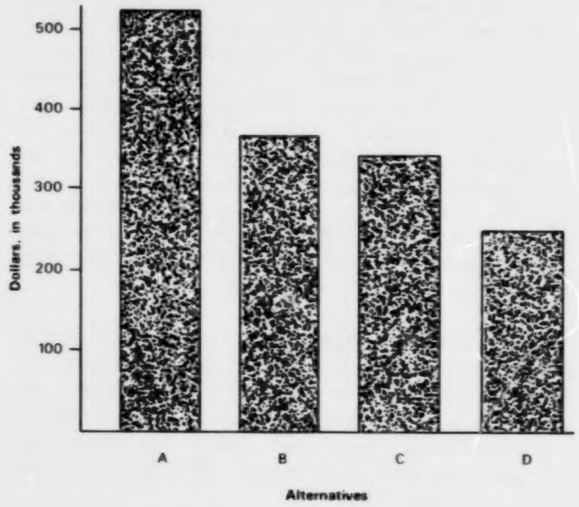

Figure I. Total Initial Cost

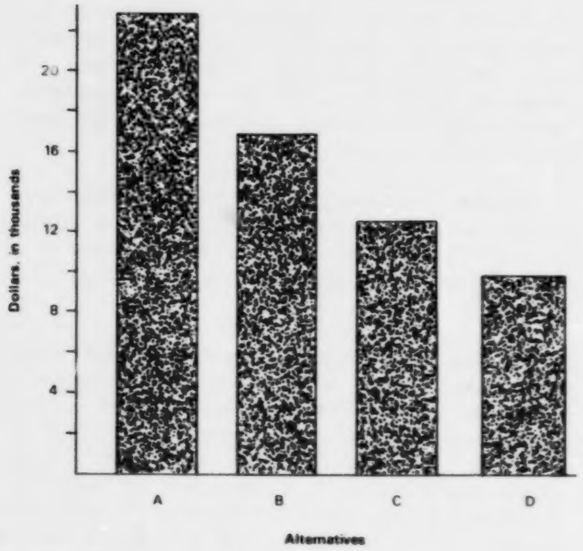

Figure II. Total Annual Funds Required

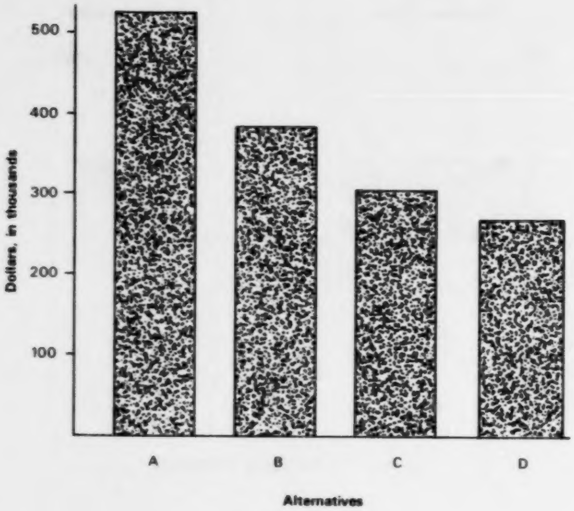

Figure III. Present Worth

In all four alternatives, it was assumed that a Federal grant for 75 percent of the initial cost would be obtained. In reality, this would be unlikely in any case.

But it could not be predicted with relative certainty how much of each alternative would be funded through a grant, and therefore equal outside funding was assumed. It was further assumed that a small "tap-in" fee would be charged each customer and the remainder of the local share would be borrowed over a 40 year period at 5 percent interest, the current FmHA loan terms. If no grant was available, the 75 percent portion would be financed locally through a greater loan and possibly a bond issuance.

The computed dollar amounts for these mean monthly bills were:

	With 75% Grant	With No Grant
Alternate A	$17.30	$37.80
Alternate B	12.80	27.60
Alternate C	7.30	17.30
Alternate D	5.70	12.90

These values are compared in Figure IV.

This analysis indicates that Alternate "A" would cost the homeowner 3 times as much as "D" and 2.4 times as much as "C", with a grant. It is recognized that the long-term financing of 95 percent of a project, as is assumed in the "No Grant" column, is rather unrealistic.

It would seem very likely that most of the "on-site" users would be unwilling to pay the monthly cost in Alternate "C" without a grant.

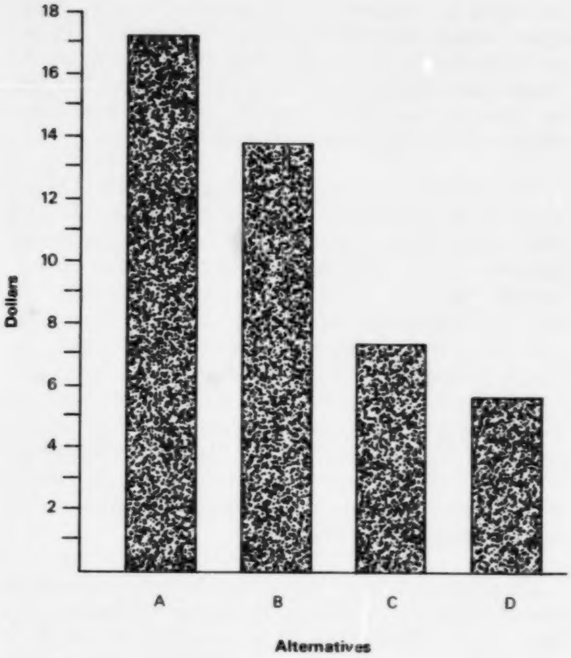

Figure IV. Average Monthly Bill

SELECTION OF THE PREFERRED ALTERNATE

These data were presented to the officers of the Water District and a public meeting was held to explain the alternates to the affected citizens. It was decided by the District Board of Commissioners that Alternative "C", the effluent sewer system with community subsurface disposal, would be the preferred alternate. Alternate "D" was not chosen, because of a general feeling on the part of the citizens that no real advantage would be gained to justify the expenditure of $5.70 per month. Alternates "A" and "B" were rejected because of the high cost to the user.

DETAILS OF THE SELECTED ALTERNATE

The design of the selected systems is fairly simple. A septic-tank and dosing tank would be placed at each user location. The effluent from the dosing tank will discharge into a plastic sewer of 4-inch inside diameter. Where the dosing tank must be located lower in elevation than the sewer, a sump pump will be used as described by Hindricks and Rees.[3] Otherwise a dosing siphon will be used to ensure scouring velocities near the lateral connection.

In a report by Otis and Stewart,[4] effluent drains are described which have been used in South Australia since 1962, apparently with no need for such elaborate devices to provide a scouring velocity. But it would seem logical to expect a reduction in maintenance flushing of the sewers where intermittent dosing was provided. Effluent would be carried to the subsurface disposal fields via the plastic sewers. No manholes are proposed for these sewers, but cleanouts would be provided at intervals to allow flushing of lines should any sediment accumulate.

The preliminary design of the disposal fields is largely based on the work by Winneberger at Berkeley.[5,6] Field applications of the "narrow-trench" concept have proven successful in the author's experience in Jackson County, Indiana, and in Appalachian Kentucky. A comparison of the trench geometry required by Kentucky State Code with that recommended in the plan is shown in Figure V. It may be readily seen that if the invert of the distribution pipe is considered the maximum design depth, then the narrow configuration provides an area per unit volume ratio of 2.33 times that of the standard configuration. Other calculations show that the total cost per useful square foot provided would be about one-half as much, using the narrower trench.

Other design criteria are rather conservative, as may be seen in Table VI. In addition to the low application rate, two sets of trenches would be provided for use on a biennial cycle. Some persons have suggested that utilization of a biennial cycle should allow a reduction of up to 30 percent in the absorption surface area provided. Bouma, *et al.*,[7] recommended an average loading rate of 1 gallon per square foot per day in moderately permeable fine silty soils, when using intermittent application of effluent. In each disposal field, alternate trenches would be connected to a common header. This would allow a more diffuse application of effluent over the entire field. A design flow of 200 gpd per user may not seem very high, but the existing water consumption in Fountain Run is only 23 gallons per capita per day (gpcd) or about 70 gpd per customer. This preliminary design rate therefore provides for nearly 3 times as much flow as is presently occurring. Intermittent dosing of the disposal fields would be provided by either pumps or automatic siphons, depending on the size and topography of the field. This would help to provide uniform loading and avoid saturated flow through soil.

In determining the optimum locations for disposal fields, available soil maps, topographic maps, aerial photographs and personal observations were utilized. Certain areas were eliminated due to the existence of soils with low permeability. Homes were grouped above available open land to try to achieve gravity flow to all disposal sites. Costs for effluent sewers were weighed against cost of disposal sites, convenience of maintenance and community acceptability. By a process of elimination, the total number of multi-user sites was reduced to 22, and 22 on-site systems in the built-up area were retained in the recommended plan. These latter users would receive a level of service equal to that provided the multi-user sites and would be charged at the same rate for services, if they chose to participate.

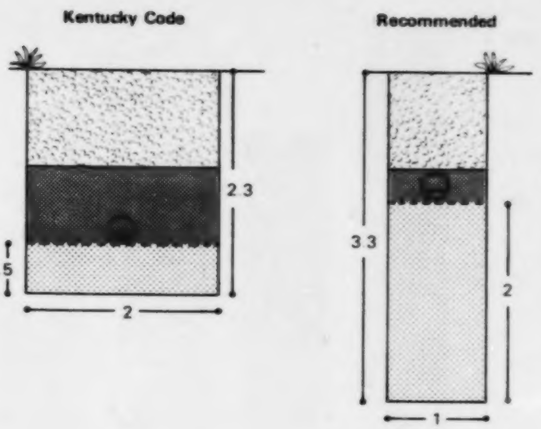

Figure V. Disposal Trenches

The pattern of septic tanks, effluent sewers and disposal fields obtained in the preliminary design is shown on Figure VI, which covers the central part of the incorporated city. Smaller sub-systems as well as on-site systems would exist in adjacent areas but were not shown in this illustration.

Due to the uncertainties presented by several very small lots on the west side of the business district, a short length of conventional sewer leading to a central septic tank was proposed. If final design investigations show that septic tanks could be placed to serve these businesses, then an effluent sewer may be recommended at that time.

Land on which the multi-user sites would be located would be owned by the Water District. Land prices are low, due primarily to the low average income level and the lack of growth pressures. Accessibility to the on-site systems would be obtained by a utility easement, which it is assumed the homeowner would give in exchange for installing a new system that would be publicly owned and maintained.

Details of construction costs are shown in Table III. Unit prices were obtained from quotes by local contractors and recent bid tabulations for jobs. No significant allowances were made for possible quantity discounts. A summary of total materials and quantities provided in this alternate is presented in Table IV.

Operating and maintenance requirements for the recommended system were more costly than might be expected. The system would contain 17 pumps of 1/3 to 2 horsepower size. Replacement units should be stocked in each size for rapid repair of malfunctioning pumps. Multi-user field dosing tanks would contain dual pumps for increased reliability.

The method used in computing total annual funds required is shown on Table V.

Table III. Detailed Construction Costs For Preliminary Design
Community Subsurface Disposal System
Fountain Run, Kentucky

	Quantity	Unit	Unit Price	Total
Subsystem 1				
On-Site Septic Tanks	34	Ea.	$ 200.00	$ 6,800
Pumps, 1/3 hp. w/tanks	1	Ea.	300.00	300
Small Dosing Siphons	33	Ea.	200.00	6,600
Effluent Sewer, 4" dia.	4,250	Ft.	4.00	17,000
Effluent Sewer, 3" dia.	790	Ft.	3.00	2,380
Main Dosing Tanks w/pumps	2	Ea.	1,200.00	2,400
Absorption Trenches	10,200	L.F.	2.10	21,420
Land	2.5	Ac.	2,000.00	5,000
Subtotal				$61,900
Subsystem 2				
On-Site Septic Tanks	2	Ea.	200.00	400
Pumps, 1/3 hp. w/tank	2	Ea.	300.00	600
Effluent Sewer, 4" dia.	450	Ft.	4.00	1,800
Gravity Sewer, 8" dia., in place	950	Ft.	10.00	9,500
8" Sewer Fittings		L.S.		1,200
Manholes	5	Ea.	500.00	2,500
Main Septic Tank, 3000 gal.	1	Ea.	750.00	750
Main Dosing Tank, w/pumps	1	Ea.	1,200.00	1,200
Absorption Trenches	5,100	L.F.	2.10	10,710
Land	1.2	Ac.	2,000.00	2,400
Subtotal				$28,660
Subsystem 3				
On-Site Septic Tanks	12	Ea.	200.00	2,400
Small Dosing Siphons	12	Ea.	200.00	2,400
Effluent Sewer, 4" dia.	760	Ft.	4.00	3,040
Effluent Sewer, 3" dia.	240	Ft.	3.00	720
Main Dosing Tank, w/pumps	1	L.S.		1,200
Absorption Trenches	3,600	L.F.	2.10	7,560
Land	0.8	Ac.	2,500.00	$ 2,000
Subtotal				$19,320
Subsystem 4				
On-Site Septic Tanks	6	Ea.	200.00	$ 1,200
Multi-User Septic Tanks	2	Ea.	300.00	600
Pump, 1/3 hp.	4	Ea.	300.00	1,200
Small Dosing Siphons	4	Ea.	200.00	800
Effluent Sewer, 4" dia.	1,270	Ft.	4.00	5,080
Effluent Sewer, 3" dia.	200	Ft.	3.00	600
Main Dosing Tank, w/siphon		L.S.		550
Absorption Trenches	3,300	L.F.	2.10	6,930
Land	0.8	Ac.	2,500.00	2,000
Subtotal				$18,960

Table III. Detailed Construction Costs for Preliminary Design
Community Subsurface Disposal System
Fountain Run, Kentucky (Continued)

	Quantity	Unit	Unit Price	Total
Subsystem 5				
On-Site Septic Tanks	7	Ea.	$ 200.00	$ 1,400
Small Dosing Siphons	7	Ea.	200.00	1,400
Effluent Sewer, 4" Dia.	1,080	Ft.	4.00	4,320
Effluent Sewer, 3" Dia.	140	Ft.	3.00	420
Main Dosing Tank, w/siphon		L.S.		550
Absorption Trenches	2,100	L.F.	2.25	4,725
Land	0.5	Ac.	3,000.00	1,500
Subtotal				$14,315
Subsystem 6				
On-Site Septic Tanks	3	Ea.	200.00	600
Multi-User Septic Tank	1	Ea.	300.00	300
Small Dosing Siphons	4	Ea.	200.00	800
Effluent Sewer, 4" dia.	720	Ft.	4.00	2,880
Effluent Sewer, 3" dia.	100	Ft.	3.00	300
Main Dosing Tank, w/siphon		L.S.		550
Absorption Trenches	1,800	L.F.	2.25	4,050
Land	0.75	Ac.	2,500.00	1,875
Subtotal				$11,355
Subsystem 7				
Multi-User Septic Tanks	2	Ea.	300.00	600
Small Dosing Siphons	2	Ea.	200.00	400
Effluent Sewer, 4" dia.	230	Ft.	4.00	920
Absorption Trenches	1,200	Ft.	2.25	2,700
Land	0.5	Ac.	3,000.00	1,500
Subtotal				$ 6,120
Subsystem 8				
On-Site Septic Tanks	3	Ea.	200.00	$ 600
Small Dosing Siphons	2	Ea.	200.00	400
1/3 hp. Pump w/tank	1	Ea.	300.00	300
1/2 hp. Pump w/tank	1	Ea.	450.00	450
Effluent Sewer, 4" dia.	500	Ft.	4.00	2,000
Effluent Sewer, 2" dia.	100	Ft.	3.00	300
Absorption Trenches	900	L.F.	2.25	2,025
Land	0.6	Ac.	2,500.00	1,500
Subtotal				$ 7,575
Subsystem 9				
On-Site Septic Tanks	3	Ea.	200.00	600
Effluent Sewers, 4" dia.	300	Ft.	4.00	1,200
Main Dosing Tank w/siphon		L.S.		400
Absorption Trenches	900	L.F.	2.25	2,025
Land	0.33	Ac.	3,000.00	1,000
Subtotal				$ 5,325

Table III. Detailed Construction Costs for Preliminary Design
Community Subsurface Disposal System
Fountain Run, Kentucky (Continued)

	Quantity	Unit	Unit Price	Total
Subsystem 10				
On-Site Septic Tanks	3	Ea.	$ 200.00	$ 600
Small Dosing Siphons	2	Ea.	200.00	400
Effluent Sewer, 4" dia.	350	Ft.	4.00	1,400
Effluent Sewer, 3" dia.	100	Ft.	3.00	300
Main Dosing Tank, w/siphon		L.S.		400
Absorption Trenches	900	L.F.	2.25	2,025
Land	0.5	Ac.	2,500.00	1,250
Subtotal				$ 6,375
Subsystem 11				
On-Site Septic Tanks	3	Ea.	200.00	600
Small Dosing Siphons	2	Ea.	200.00	400
Effluent Sewer, 4" dia.	400	Ft.	4.00	1,600
Effluent Sewer, 3" dia.	50	Ft.	3.50	175
Main Dosing Tank, w/siphon		L.S.		400
Absorption Trenches	900	L.F.	2.25	2,025
Land	0.33	Ac.	3,000.00	1,000
Subtotal				$ 6,200
2-Unit Disposal Systems (Sites 12 through 22)				
On-Site Septic Tanks	14	Ea.	200.00	$ 2,800
Multi-User Septic Tanks	4	Ea.	300.00	900
Small Dosing Siphons	14	Ea.	200.00	2,800
1/3 hp Pump & Tank	1	Ea.	300.00	300
Effluent Sewer, 4" dia.	1,220	Ft.	4.00	4,880
Absorption Trenches	6,600	L.F.	2.25	14,850
Land Cost	1.8	Ac.	3,000.00	5,400
Subtotal				$31,930
Individual Disposal Systems				
On-Site Septic Tanks	22	Ea.	200.00	4,400
Small Dosing Siphons	22	Ea.	200.00	4.400
Absorption Trenches	6,600	L.F.	2.25	14,850
Subtotal				$23,650
Total Treatment & Disposal Costs				$241,685
Sludge Pump, Soil Injector and Truck				20,000
Grand Total				$261,685

Table IV. Summary of System Components

122 Septic tanks;
13,250 Linear feet of effluent sewer;
960 Linear feet of 8" sanitary sewer;
104 Small dosing siphons;
9 Small effluent pumps;
4 Main dosing tanks with pumps;
6 Main dosing tanks with siphons;
44,100 Linear feet of absorption trenches at 44 sites;
10.6 Acres of Land;
1 Set sludge pump and soil injection equipment.

Table V. Alternative C Annual Fund Requirements

Operation and Maintenance		$ 6,100	
Office and Billing Expense		1,000	
Subtotal			$ 7,100
Debt Service			
Construction Cost		$261,685	
Engineering, Legal & Contingencies @ 30%		78,506	
Total Initial Cost		$340,191	
Less Grant (75%)	(–)	255,143	
Local Share		85,048	
Less Tap-On Fees @ $50 ea. (130)	(–)	6,500	
Net Debt Amount		$ 78,548	
(Assume 40 yr. loan @ 5% Use Capital Recovery Factor of 0.05828)			
Average Annual Principal & Interest		$ 4,578	
Surplus for Reserves at 20%	+	915	
Total Debt Service Funds			5,493
Total Annual Funds Required			$12,593

Table VI. Design Features For Subsurface Disposal

1. Application Rate: 0.33 gpd/sq. ft.
2. Biennial Use of Alternate Disposal Trenches.
3. Width-Depth Ratio of Disposal Trenches: 1.3.
4. Design Flow of 200 gpd per Customer.
5. Intermittent Application of Effluent.

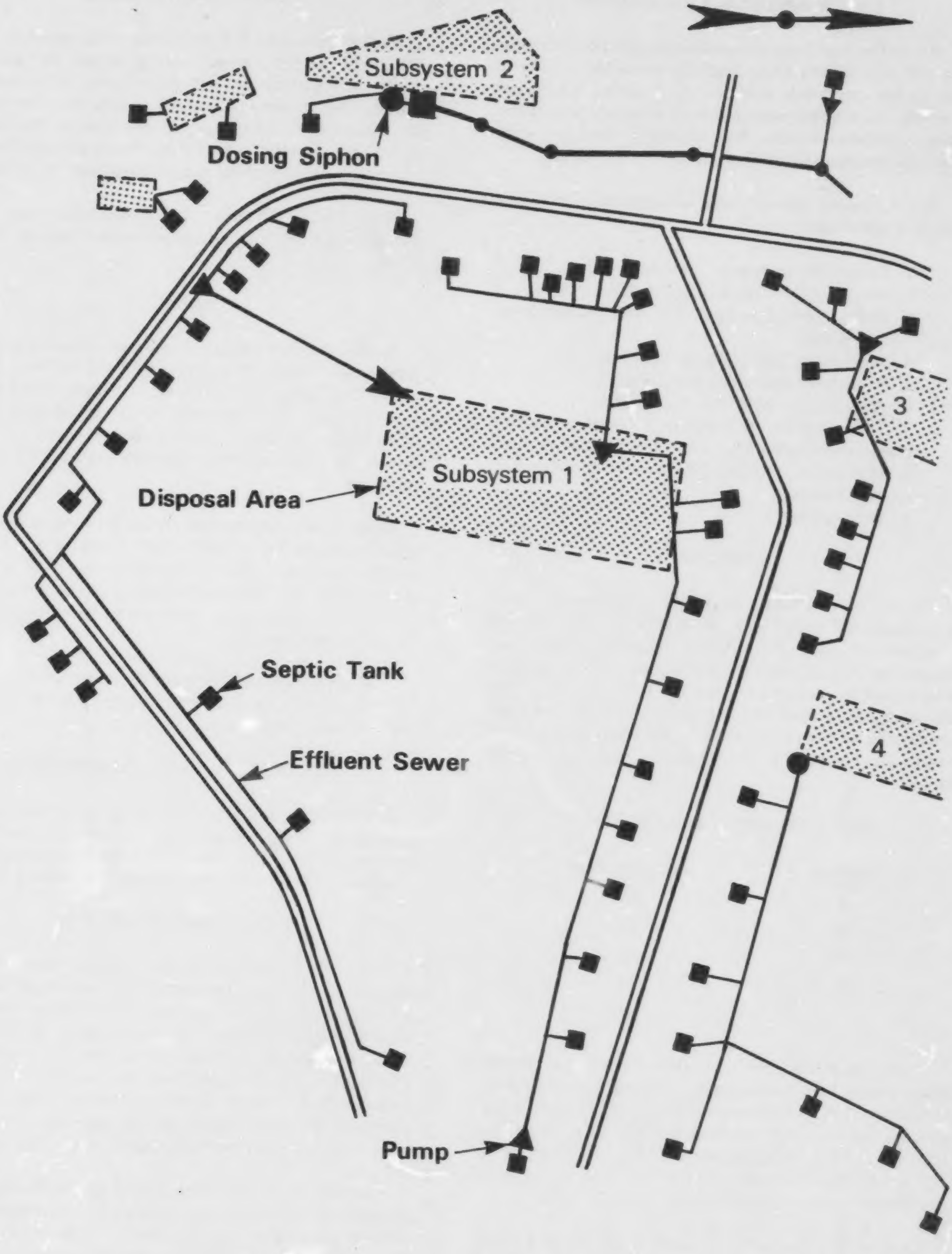
Subsystem 2
Dosing Siphon
Subsystem 1
Disposal Area
3
Septic Tank
Effluent Sewer
4
Pump

Figure VI. Community Subsurface Disposal Plan

ENVIRONMENTAL EVALUATION

All of the four basic alternatives would appear to meet the effluent criteria and other environmental criteria of responsible regulatory agencies. As in most wastewater projects, the primary impacts are more readily determined than secondary impacts. The following discussion only describes the more significant environmental effects.

The following factors were considered in analyzing construction effects:

1. Erosion from sewer construction.
2. Erosion from treatment and disposal sites.
3. Stream-bank damage from sewer lines and treatment facilities.
4. Aesthetic effects of excavation, etc.
5. Noise from construction equipment.
6. Air quality effects from fugitive dust.
7. The presence of sensitive ecosystems, unique plants, endangered species and archaeo-historic sites.
8. Dislocation of individuals, businesses and governmental services.
9. Employment.

EROSION

Erosion was estimated for each alternative by assuming a uniform soil erodibility (K factor) for the soil (the dominant soil type) and uniform erosion control practices (mulching) and estimating the steepness of the affected area by use of a topographic map. The Universal Soil-Loss Equation was applied to these assumptions and the total annual soil loss was adjusted to the estimated time of construction exposure. The results of these calculations follow.

SOIL LOSS FROM CONSTRUCTION

Alternate	Soil Loss, Tons
A	30
B	25
C	6
D	2

From this table it may be predicted that the conventional gravity sewer system and lagoon with disposal in an infiltration basin (Alternative "A") would create the greatest soil loss. The least soil loss would be created by Alternative "D", using on-site disposal and Alternative "C" would create slightly higher losses than "D" due to the effluent sewers being provided.

Since all such losses would be distributed over a fairly large area in a "non-sensitive" environment, no significant adverse impact would be anticipated.

STREAM-BANK DAMAGE

Damage to stream banks in the form of earth cuts and fills would be experienced in Alternatives "A" and "B" due to the construction of a 2-acre lagoon in the bed of a stream. This construction would require the diversion of the intermittent stream around one side of the lagoon. Additional damage could occur from construction of sewer lines crossing streams in Alternatives "A" and "B".

Alternatives "C" and "D" would not cause such damage since no major construction is proposed in any stream.

NOISE

Since larger construction equipment generally produces greater noise levels, Alternatives "A" and "B" would tend to produce greater significant noise impact than Alternatives "C" and "D". However, the most noise would be produced by bulldozers constructing the lagoon, and the lagoon site is located more than 500 feet from the nearest residence.

Sewer line construction in an existing community often produces noise levels which exceed the U.S. EPA criteria for noise. Since the construction of effluent sewers, as in Alternatives "B" and "C", would be done with smaller equipment, fewer excessive noise incidents would be expected.

The total lack of pavement crossings in Alternative "D" would indicate that this alternative would have the least adverse noise impact.

OTHER IMPACTS FROM CONSTRUCTION

All other potential impacts from construction were considered to be insigificant. No rare or endangered species, sensitive ecosystems or historic sites would be adversely affected by any alternative considered feasible.

GROUNDWATER EFFECTS

All of the final alternatives utilized some form of disposal to the soil. Consideration of soil conditions and the hydrogeology of the area have shown that the possibility of groundwater contamination by the proposed facilities is remote. All soils considered for disposal are fine textured and moderately well drained. They are considered to have a large capacity for absorption of ammonia nitrogen, nitrate and phosphorous. No higher groundwater conditions were evident in any disposal area.

Concern is often expressed in engineering reports about nitrate contamination of groundwater below septic-tank effluent disposal fields. An attempt was made by Rajagopal, *et al.*,[6] to relate groundwater quality to septic tank densities in an area with sandy soils and fairly high water table. In 123 samples, only nitrates were found to approach or exceed USPHS limits for drinking water. Only 6 samples had concentrations in excess of the standard, and these were apparently caused by fertilization of cherry orchards, not by septic tanks. Where no orchards were nearby, nitrate apparently did not exceed 2 ppm (as NO_3-N) average concentration.

More detailed consideration of the location of any existing wells will be made in the Step 2 (design) process. Nearly all persons in the area of concern are customers of the Water District, but a few private wells may still exist, and if so, adequate separation distances from disposal sites must be provided or the wells should be abandoned and sealed.

The potential for overflow of partially treated wastewater in the effluent sewer system is probably much less than the potential for overflow of raw wastewater in the conventional system. This is due in part to the provision of on-site storage of several hours capacity in the dosing tanks and septic tanks. A typical 1,000 gallon septic tank would have a reserve storage capacity of about 100 gallons with a rise of 6 inches in liquid level. This would equal about 12 hours of average flow, which should be sufficient time to complete most repairs or replace failed pumps.

In addition, hydraulic overloads from infiltration and inflow appear to be much more likely with conventional sewers than with effluent sewers, due to the relative integrity of joints and the presence of manholes in the conventional system. Investigations of infiltration and inflow in existing sewer systems have demonstrated that untreated discharges were common in all systems.

Further protection against accidental overflow in effluent sewers could be provided by small emergency sand filters located adjacent to disposal field pumps, or by emergency subsurface disposal trenches.

SUMMARY OF CONSTRUCTION & OPERATING EFFECTS

Each of the effects described above has been given a numerical rating and the ratings added to give a total for ranking purposes. The total rankings, in ascending order of possible negative impact, were:

1. Alternative "D" = 29
2. Alternative "C" = 30
3. Alternative "B" = 37
4. Alternative "A" = 40

SECONDARY IMPACTS

Conventional gravity sewers often are considered to stimulate growth and encourage new industry to move to an area, where excess capacity exists in a sewerage system. Of course, this is dependent on many other factors as well, such as availability of general and skilled labor, transportation facilities and distance to markets. Nevertheless, it would appear likely that conventional gravity sewers as considered in Alternative "A" would tend to cause more development and, therefore, create a potential for greater secondary impact than Alternatives "B", "C" and "D".

EVALUATION OF IMPLEMENTATION

Based on the consultant's understanding of the powers of Water Districts, any of the alternatives could legally be implemented by the District. Alternatives "C" and "D" are apparently unique proposals in Kentucky and for that reason, may entail more original thought and careful evaluation for successful implementation.

On the other hand, the conventional sewer with central treatment would require such a large expenditure of local funds, even with Federal assistance, that opposition from potential customers may be even greater than anticipated. Alternatives "A" and "B" may also require a trained operator, or at least require considerably more manpower than the other alternatives, which would be a disadvantage.

Alternative "D" would seem particularly difficult to implement from the standpoint of the 20% of homes located on soils of low permeability. As pointed out previously, that alternative could involve much higher costs for design and construction of the systems located in poor soils than was used to determine relative present worth. From this standpoint, Alternative D was not recommended.

In perspective, none of the alternatives had any overwhelming advantage for implementation. Further consideration of implementation is contained in the Facilities Plan.

PUBLIC PARTICIPATION

A notice of public hearing for discussion of the environmental inventory and alternatives developed in the Plan was published in a local newspaper. About 15 community leaders attended the hearing.

Discussion during the meeting centered around Alternative "C", the community subsurface disposal system. Alternative "A", conventional sewers and central treatment, was considered too expensive by all participants. Even Alternative "B", the effluent sewer system with central treatment, was considered too expensive for local income levels. Several participants mentioned the fact that a significant portion (local estimates were 30 percent) of the population was living on retirement income and Social Security.

It was pointed out that the element of risk of "failure" may be higher in Alternative "C" than with conventional sewers, due to the complexity of soils and relative sensitivity to errors, but that any failure would probably only affect a few persons and would be correctable. The importance of the central management concept to correcting problems was explained.

To those attending who had no immediate problem with their individual disposal systems, even the expenditure of $7.00 per month seemed to be little justified when the discussion was commenced. An objection to Alternative "C" was that it might not attract new industry in the manner hoped for by some citizens. Some questioned whether as many persons would "sign up" for services as had been projected, and this led to a discussion of the possible mandating of subscriptions by health authorities or city ordinance. An opinion of the State Attorney General advised that Water District Commissioners would have legal authority to require use of a sewer system.

The participants largely agreed that the community disposal system would be a more desirable improvement and that Alternative "C" would probably not cost any more than maintaining and replacing existing septic tank systems. Several persons mentioned neighbors and business places where septic tank failures were known but have not been corrected.

Since the majority favored Alternative "C", subsurface disposal, due to the lower cost and simplicity of operation, the Chairman instructed the consultants to proceed with Alternative "C" as the preferred alternate.

CONCLUSIONS

The community subsurface disposal concept favored in this Plan is not a new concept. But it has had little, if any, application. To the best knowledge of the author, no demonstration has included the mix of septic-tanks, effluent sewers, community subsurface disposal and on-site disposal recommended in the Plan. Since the overall concept is somewhat new and unfamiliar to the Federal funding agencies, the possibility of substantial Federal assistance is unknown. On the Kentucky State Priority Ranking, the project is listed as 240th out of 241. This low rank is due primarily to the lack of recognized wastewater discharges in the local area. Malfunctioning septic tank systems are not included in the weighting system for determination of need.

The low ranking given not only delays funding of the project, but it also delays approval of a project. Personnel at the U.S. EPA Regional Office have stated that the Fountain Run Plan would not be reviewed for approval until higher ranking projects had been reviewed, and no timetable for such review was available. The most recent advice from the State Office is that funding of this Project is at least 10 years in the future, assuming funding levels do not increase. Therefore, other sources of funding are being investigated.

In discussing the proposed system with persons in various positions, from citizen to regulator, it seemed that most persons are initially prejudiced against all these key elements of the concept. Retaining septic tanks at the individual wastewater sources seems to violate what most sanitary engineers and citizens feel is right – that all wastes should be carried away from the point of generation as quickly as possible. Similarly, it violates common practice to specify a sewer as small as 4-inches diameter, when in some local jurisdictions 8-inch sewers are laid right up to the house foundation. And the history of subsurface disposal of wastewater has been so filled with negative experiences that regulatory officials sometimes are unable to give this alternative serious consideration.

But in the final analysis, the facts about the monetary and environmental advantages of community subsurface disposal in Fountain Run are still true. If this concept is ever to be applied at the required scale, decision-makers at both the State and Federal levels will need to take positive action based on the facts. When this is done, it will then seem more feasible to apply these concepts as alternatives in other communities. But without such positive action, most plans will continue to be written as though there were no alternatives to conventional sewers.

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BOYD COUNTY DEMONSTRATION PROJECT

Lawrence E. Waldorf[*]

BACKGROUND

Traditionally there have been two choices, once it is agreed that rural sanitation is a problem which should be addressed. At one end of the spectrum has been municipal collection and treatment facilities; at the other extreme, individually owned and maintained septic tanks, outhouses or some other "devices." Between the two extremes there has been a great void; and, when either the cost of municipal facilities was too high or septic tanks would not function, nothing was one. In rural Appalachia, not to mention the rest of the United States, for hundreds of thousands of families, the cost of municipal collection and treatment is not economically feasible, even with 75% grant money from EPA. Because of the combination of low population density and severe topographical problems, the cost of providing municipal collection and treatment is now regularly between $5,000 and $10,000 per house. For example, in West Virginia's Hepzibah Public Service District, a system designed to serve 150 homes had an estimated cost of $1.2 million or $8,000 per house. In Garrett County, Maryland, a system built with ARC funds cost $8,500 per house. Another system in the same area cost $8,700 per house. The result of these high construction costs has been high user fees such as that experienced by a small community in Monroe County, Pennsylvania. Here, in order to finance a municipal collection and treatment system, even with the assistance of both EPA and ARC funds, a tap-on fee of $500 was charged, and a service charge averaging approximately $20 per month assessed. These are actual projects in our records at the commission, and it was this kind of project which prompted ARC to try to find some alternatives which would help to fill the gap between municipal treatment and individually maintained septic tanks.

There are still 2,700,000 homes in Appalachia alone which do not have access to public sanitary facilities. One of the primary reasons for this is that the option of high-cost municipal collection and treatment facilities, with their resultant excessive monthly charges, is not suited to the needs of the people in many rural areas. As Senator Randolph has stated before in the U.S. Senate,[1] 19,500,000 households across America are not served by public sanitary facilities, and these famil ities must provide for themselves some method of home disposal for the nearly 3 billion gallons of domestic sewage which they generate daily. These conditions exist despite the appropriation by Congress of tens of billions of dollars for the construction of sanitary facilities.

The "System Approach to Individual Home Treatment" is an attempt by ARC to develop a tool which can be used to fill the gap between municipal treatment and collection, and individually owned and maintained septic tanks. It is not *the* answer to the problems of rural sanitation. No one has *the* answer, because the problems are so diverse that only a serious, ongoing program to improve and develop new tools which can become parts of a total answer is a realistic solution. What is needed is an inventory of tools between the two extremes, from which the rural sanitation engineer can draw those which are best suited to his particular situation. The system approach is an attempt to develop one of those tools, to be one component of that inventory.

The Boyd County system approach is based on two important assumptions:

1. The average homeowner either cannot, or will not and probably should not, properly assume the maintenance of his own sanitation device.
2. Rural families are entitled to the same quality of public service as those living in more urbanized areas.

Our project, therefore, is based on the premise that rural sanitation must be treated as a public utility, i.e., all equipment involved must be owned, operated and maintained by a public body—in this case, a public sanitary district. For purposes of system maintenance and eligibility for Federal grant funds, this concept is essential.

PROJECT DESCRIPTION

The project area is located approximately five miles from the Huntington Airport in Kentucky. The area has the typical characteristics of low population density and rough topography found throughout Appalachia. There are about 60 families living within the boundaries of the sanitary district. This project serves 47 of these families

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and includes 36 individual home aeration treatment plants, and 2 multifamily aeration plants serving 11 families. One of the goals of the project was to build into the system for demonstration purposes as many variables as possible with respect to equipment installation. The aeration equipment being used in Boyd County is manufactured by Multi-Flo, Cromaglass, Flygt, Bi-A-Robi, Jet, and Nayadic. Most of the conference attendees are probably familiar with this equipment, because each of these manufacturers has received the NSF seal.* Within the overall sanitation system, there are 16 stream discharge units, two spray irrigation units, and one evapotranspiration unit. The remainder of the units rely on subsurface tile field discharge. In addition, four families are using recycled wastewater from a single installation.

The sanitary district employs a licensed sewage treatment plant operator to monitor, service and test all equipment in the project. Each unit in the project has a control panel which will alert the homeowner of any malfunction. Should a malfunction occur, the project operator is on call to handle emergencies.

INSTALLATION AND RESULTS

Two years ago, at the first NSF Onsite Conference, it was stated that "What we are trying to prove is that home aerobic systems seem to be a viable alternative to municipal teatment facilities in places where it costs $8,500 per house to put in a municipal treatment plant." The commission feels that an objective analysis of the equipment now in use in Boyd County must support the contention that this equipment is a workable alternative. The test results achieved thus far at Boyd County indicate a remarkable similarity to the tests conducted here at NSF. The conclusion drawn from this fact is that, despite the very different and fluctuating condition encountered in the field, the system approach concept with regular inspection and maintenance can, and has, assured optimum operation of the various installations.

It was necessary in many cases in Boyd County to use stream discharge for the disposal of treated effluent, because, with the limited size or layout of the homesites involved, surface disposal was the only way these families could be served. The equipment which has been in service for many months now has consistently met or exceeded EPA stream discharge requirements. After initial treatment, all steam discharge units at Boyd County are followed by sand filtration and disinfection. It should be kept in mind that all homes which now are using surface discharge were previously either dumping raw sewage into Upper Chadwick Creek directly, or allowing septic tank runoff to flow into the creek.

For the surface discharge systems which have been in operation long enough to gather results (most of these are Multi-Flo), some rather consistent patterns have developed. The following table is a composite of surface discharge test results over the last five months:

DO, mg/l	pH	Temp, °F	SS, mg/l	BOD, mg/l
0.5-8.0	6.24-7.88	78-90	1-44 80*	2-11 47*

*The results of one test following a unit malfunction.

Naturally, some units have performed better than others, and equipment malfunctions have occurred. The main equipment problem has been the failure of electric pumps. To date, the operator has had to replace nine malfunctioning pumps, all of which were under warranty. However, such malfunctions do show clearly on test results. Specific instances at Boyd County have yielded test results with suspended solids counts that range as high as 358 mg/l on subsurface discharge units.

Two other components of the project deserve special mention: evapotranspiration and wastewater recycling. At the O.T. Carter residence in Boyd County, with the assistance of the Cromaglass Corporation, the sanitary district has constructed a 2000-square foot evapotranspiration (ET) bed for the disposal of effluent from a Cromaglass model C-5 aeration plant. The ET system, which is actually two 1000-square foot beds, is sealed with plastic to prevent the high ground water at the site from flooding the beds. Constructed with 8 inches of gravel and 18 inches of sand, the beds are crowned to facilitate rainwater runoff. Covered with a layer of topsoil, the beds have been planted with grass and junipers.

One of the values of an in-the-field test of such equipment is to observe the system's reaction to changing circumstances and shock loading. In the case of this particular evapotranspiration system, the design was intended to serve the needs of a family of four; however, because of a tragedy in the family, seven people now live at this site, including three small boys. While the result has been a large increase in water usage, particularly for laundry use, the evapotranspiration bed has thus far performed extremely well with only a slight modification to the distribution box. Prior to the installation of the treatment plant and ET bed, raw sewage stood in the yard of this house from an inoperative septic tank and drainfield, although the water usage was much lower than it is today. Although the high rainfall in the area caused some doubts as to whether the evapotranspiration concept would function properly, the results thus far have been very satisfactory. However, any final judgment on this installation should await monitoring of its performance through the winter and spring months ahead.

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*The Cromaglass model designated C-5 has not been listed by NSF and is not authorized to display the NSF seal.

One of the most important and perhaps most controversial components of the Boyd County project from the outset has been wastewater recycling. This component appears to have been controversial to nearly everyone except the families involved in the demonstration project. In fact more requests were received for recycling equipment within the district than could be met. Because the use of this equipment was a source of considerable debate, it is particularly gratifying to find that it has been one of the most successful components of the project. Four recycle systems, serving five homes, are part of the overall Boyd County system: three Multi-Flo units, and one Cromaglass unit. At this time, however, test data are available only on the Multi-Flo equipment.

The recycling systems at Boyd County are composed of a treatment plant, holding tank, disinfectant, polishing filter and pressure tank. The standard treatment plant is followed by a 1000-gallon holding tank used to regulate flow by assuring an adequate quantity of relatively clean water for the recycling equipment, even in the event of a temporary problem with the treatment plant. From the holding tank, water is pumped past an iodine disinfectant, receiving a constant dose of 0.5 ppm. A small contact tank is used to retain the iodine-treated water for 20 minutes to allow for maximum disinfection. From here the water is filtered in a charcoal column equipped with automatic backwash to reduce maintenance. The charcoal removes iodine from the water, and provides a final polishing cycle by further reducing suspended solids before the water enters the pressure tank, ready for reuse.

Tests show that this recycle system provides extremely consistent results. A clear, odorless water of excellent quality is produced with suspended solids averaging 5 mg/l, and a zero fecal coliform count. Equally important has been the high degree of consumer satisfaction with the day-to-day use of recycled water.

Also at the first NSF Onsite Conference, it was stated that ". . . . one of the most significant aspects of the system approach for the future is that if we form a sewer district, a body of municipal government, it gives us for the first time a vehicle by which the Federal Government can participate in the funding of home onsite sewage treatment plants." The goal was first to show that the sanitary district or system approach was a workable solution for the management of a rural system of onsite equipment, then to work with other Federal agencies to provide grant funds for such systems. Although the Boyd County testing program will continue for some time, the initial results indicate that the system approach is indeed a workable idea for rural areas. Through the efforts of Senator Randolph and his excellent staff, and the many people at EPA who have expressed interest in the project, the ongoing funding for projects using the system approach is now a reality.

LESSON LEARNED

At this point, with the option for Federal funding before us, it is important that we also point out some of the pitfalls and lessons of the Boyd County project. One of the most important and difficult problems in Boyd County has been simply getting the system built. Two years ago it was expected that, by this time, the demonstration would have been completed. Today, however, systems serving 24 families are now in place, with an additional 11 units now in the installation process. In the next month, an additional group of six installations will be made. There are three basic reasons for this slow pace of project completion, and each is important to the success of future systems. The first problem has basically been one of grants management, and has resulted in no small measure from unfamiliarity with the complexities to be encountered on the part of both the commission and the grantee. This has now been resolved through negotiations with the grantee. Basically, this is an internal matter that other Federal agencies can avoid through careful preparation of grants management guidelines.

The second problem was one of legal delay. As with many new ideas, there has been a cautious attitude on the part of State and local regulatory officials who are responsible for public safety and health. Although frustrating at times, this cautious attitude, when viewed from a long-range perspective, is important to avoid serious mistakes involving the well-being and safety of the general public. Therefore, a great deal of time was spent in securing the necessary approvals to begin the implementation of the project while insuring proper safeguards. With more systems being constructed with Federal grant funds, and the resulting familiarization with the advantages and limitations of alternative systems, this reluctance toward alternative systems should begin to diminish in the near future.

The third problem is that not many engineers and contractors are, as yet, familiar with standards, methods and requirements for the most efficient installation of alternative systems, particularly in the wide variety of installation problems found in servicing all homes in any given rural area.

Basically, there is a great need for the widespread availability of technical information on the design, installation and operation of alternative systems. The lack of an adequate technical base is one of the reasons that the Boyd County project has not been installed efficiently, resulting in duplications of effort and higher costs. It was found in Boyd County that it is a very complex task to install a system of individual units, and general expertise in this field is not yet available. There is a definite need for a detailed engineering study which takes into account the particular needs of each family being served, including family size, site layout, appliances in the home and many other factors.

It is important to note that wherever possible, i.e., where pressure was available, iodine was used as a disinfectant rather than chlorine. Thus far in the program, we are satisfied that iodine is very reliable. Finally, it has been found that, where applicable, multifamily units offer greater economy of installation and operation, and greater efficiency for maintenance purposes.

OUTLOOK FOR THE FUTURE

Looking to the future, now that we can see the emergence of alternative systems as a recognized, accepted tool for addressing the problems of rural sanitation, we are hopeful that other Federal agencies will follow the lead of EPA. This is particularly true of the Farmers Home Administration (FmHA), which over the years has been so responsive to the needs of rural America. The Farmers Home Administration has a total of $800 million for water and sewer system construction ($200 million for grants and $600 million for loans). Unlike other major Federal programs, FmHA is specifically charged with meeting the needs of rural America. Involvement in the system approach alternatives will help that agency serve more people with the resources that it has available.

It is essential at the outset that we proceed wisely so as not to abort the new grant process in its infancy.

For both the industry involved in alternative systems and for regulatory officials, it is extremely important that a comprehensive manual be developed (similar to the *Manual of Septic Tank Practice)* which will put into the hands of sanitarians, engineers and health officials an authoritative "How To" book on methods, standards and procedures. Such a manual, based on the experiences of the Boyd County project and the numerous other installations around the country, should provide specific information with respect to system applications, uses of disinfectants, surface and subsurface disposal system construction, recycling, etc. The value of such a manual cannot be overstated in the development of future systems, both as a guide and as a statement of minimum standards. In fact, the need for such a manual is so important to the whole concept of rural sanitation in Appalachia and elsewhere, that I would like to announce that the Executive Director of the Appalachian Regional Commission, Mr. Harry Teter, Jr., will within the next few months request the participation of industry, government funding agencies, and experts in the field to gather in Washington, D.C. to discuss the funding and composition of a representative committee to assist in the development of such a document.

Secondly, I urge the industry to establish a trade association which can effectively set industry standards and can present the industry's viewpoint in the drafting of future legislation and regulations which affect rural sanitation.

Further, with respect to future Federal grants for a system approach, it is equally important that the parameters for funding alternative onsite equipment be structured in such a way as to insure that the end-product will resemble the intent, namely, to improve environmental health conditions in rural areas by providing sanitary services which are effective and within the financial reach of rural areas which have incomes below the national average. Obviously, no matter how good a proposed solution (or tool) may be, it is worthless if the intended users cannot afford it. It must be kept in mind during this discussion, that we are referring to relatively small systems serving perhaps less than 250 families. Therefore, the commission urges the consideration of the following funding proposals by other Federal agencies:

First, the initial construction grant should provide not only for the purchase and installation of equipment, but should provide funds for an initial 90-day startup period for the system. This startup is a critical period of adjustment in which numerous unforeseen problems may arise requiring a great deal more maintenance than the normal operating period. Funded as a component of the basic construction grant, this 90-day period would assure adequate attention to the equipment without depleting the resources of the newly formed sanitary district with very limited capital. During this 90-day startup period, the sanitary district should be encouraged to collect its established maintenance fee so that, at the end of the startup period, the district will have sufficient operating capital to provide quality services on better than a marginal financial basis.

Another essential element of the initial construction grant should be the ability to stock spare parts and tools. This is essential from both the standpoint of starting the sanitary district off on the right foot as a financially self-sustaining, ongoing service organization, and from the standpoint of providing effiecient maintenance. For example, the operator of the system will not have time to stand out in the rain trying to determine why a pump or other pieces of equipment are not working. Provided with an adequate parts inventory, he can simply replace nonfunctioning equipment and examine it for possible repair at a later date, as time permits.

Finally, and perhaps most controversial, as part of the initial grant for equipment and installation, the Federal agency regulations should provide for *one* service vehicle for a community initiating a "system approach" concept. Such eligibility should be restricted as to the maximum dollar amount by a sliding scale based upon the number of families to be served, within an overall maximum and minimum size. This eligibility should be on a one-time only basis and with an explicit prohibition against replacement.

The point of these recommendations on future Federal funding is to insure that our ultimate purpose will be attainable. The purpose—affordable, effective sanitation for rural areas. Whatever we can do at the Federal level to get new sanitary districts using a system approach with onsite equipment off to a good strong financial start, will serve us well for years to come. We are on the verge of a new era in meeting the needs of rural America. Let's start here to assure that the challenge ahead will be successfully met.

REFERENCE

[1] "Senator Randolph Stresses the Need to Explore New Sewage Treatment Concepts," *Congressional Record* 122:152 (October 26, 1976).

A CONSULTANT'S OVERVIEW OF ON-SITE NEEDS

*John T. Winneberger**

INTRODUCTION

Einstein searched for the common denominator of the universe and philosophers searched for common denominators of human experience. They must have been lonely men, surrounded by people segmenting unifying concepts and understanding ideas only in terms of real devices. Concepts become reality slowly and usually only in response to great need.

THE OSWMD CONCEPT

California has had no greater need for the On-Site Wastewater Management District (OSWMD) than other States. Still, California has been the vanguard of the concept, but only because someone with the concept in mind was there when a chance came to apply it as much as practical. There is a need for understanding the concept and applying it as often as practical to do so.

Essentially, the OSWMD concept is:

1. Provision of public responsibility with matching authority, for management of all wastes; and,
2. Return of all wastes to an assimilative environment, as close to sources of generation as is practical.

A LOGICAL PROGRESSION

Years of neglect led to the environmental movement. And when the EPA was created, there was a huge job to be done. Understandably, first efforts were directed towards greatest sources of pollution, and public sewerage collected the largest volumes of pollutants. Concurrently, public sewers were constructed because public sewerage compared to on-site sewerage, has always been simpler in technical concepts, simpler to manage, and easier to find. Energies have been directed towards providing public sewerage in many places, but everyone knew that we couldn't sewer all of the nation and the day would come when we would be forced to face that fact. That day has come. Witness this EPA first: National Conference on "Less Costly Wastewater Treatment Systems for Small Communities."

For a variety of reasons, minor public sewerage will likely receive major attention, and pressure sewers seem the likely device. Later might have been on-site devices, but a common component, the septic tank, might assist co-evolvement of minor sewerage and on-site sewerage. Also, the OSWMD concept embraces both devices.

The EPA and the OSWMD concept have a future together. Economics demand it, students of governmental progressions would predict it, and people and their environment would benefit from it.

PRESSURE SEWERS

Effluent Collection

A most promising, less costly wastewater treatment system for small communities and perhaps urban fringes appears to be the pressure sewer. Treatment begins within individually located septic tanks, from which effluents are pumped into pressure mains and transported to sites of final treatment. If septic tanks, pumps, mains, and final treatment plant are publicly owned, the system is public and might be governed by conventional laws, agencies, and such.

Pressure sewers are less costly than customary gravity-flow sewers and do not pose difficult technical problems. They are not a common tool of sanitary engineers, but can be easily understood. Sumps, pumps, and pipes are hardware, available in good quantities, and are always being improved. Pressure sewers which collect effluents, however, have septic tanks, or the same devices identified by some other name. Septic tanks used in pressure sewers are not well understood and many functions are technical mysteries. It is suggested that:

1. The EPA could study septic tanks as "extended primary sedimentation basins," with emphasis on production of effluents best suited for pressure sewer collections and final dispositions.

ON-SITE WASTEWATER MANAGEMENT

Public Responsibility to Replace Private Responsibility

The myriad of household situations, devices available for on-site treatment, and absence of competent on-site management, point to the need for the on-site wastewater management district, the OSWMD. Once the OSWMD is available, septic-tank systems and other treatment devices, may become suitable where they were not before. Therere, the OSWMD concept constitutes a less costly wastewater treatment approach for small communities.

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The OSWMD concept has become topical. Largely from efforts of Gary Plews, R.S., for example, statewide guidelines for OSWMDs are now provided in the State of Washington. The EPA has expressed interest through support of interested staff of the Small Scale Waste Management Project, University of Wisconsin. Doubtless, districts will be started in many places and some may be grant-supported.

Grant-supported OSWMDs risk becoming economically unable to stand alone when outside funding ultimately leaves. It is not always obvious how to guide a financially dependent project into financial independence. In California, the OSWMD concept has become reality in various ways and degrees. Each California OSWMD has been self-starting and, ignoring imperfections, economically sound. Therefore, California's OSWMDs could serve to guide efforts elsewhere towards economically sound practices. It is suggested:

> 2. The EPA could study the history of evolvement of California's OSWMDs, their economics, practices, and likely futures.

Cursory descriptions of OSWMDs and guidelines for them have been discussed in draft: Winneberger, J.T., and J.A. Burgel; *On-Site Wastewater Management (Rural Wastewater Disposal Alternatives), Final Report, Phase I;* Report from the Governor's Office of Planning and Research to the California State Water Resources Control Board; P.O. Box 100, Sacramento, California 95801; In preparation.

The OSWMD concept is broad. In application, an OSWMD might design, construct, own, and maintain both on-site systems and, if needed, a common sewer to some sites leading to a common treatment facility. From such total management of all wastewaters, OSWMD applications could range down to perhaps a district without contiguous boundaries and providing information to homeowners until economics permit more services. Thus, it is believed proper to suggest that:

> 3. The EPA could endeavor to provide guidelines for OSWMDs capable of little to total responsibilities, and to demonstrate their value.

Manuals, Standards, Guidelines, etc.

The USPHS *Manual of Septic-Tank Practice* was not intended to be ubiquitous law. Nevertheless, what were intended to be guidelines for a kind of on-site systems, became rigid regulations in many places. Soon it was believed, for example, that seasonally high groundwaters always needed to be 4-feet or more below the bottom of a disposal field, physical reality notwithstanding. That and other restrictive and technically unsound regulations have needlessly deprived some property owners of their rights.

Worse yet, some zealous authorities wishing to bypass public judgments, have found restrictive septic-tank regulations an excellent subterfuge in personal efforts to control land use, to control kinds and densities of developments, and to curtail growth. The EPA, being a potent national authority, might unintentionally worsen matters by provision of rather specific "guidelines", granted by knowledgeable scientists to be unsound.

There are current efforts to produce manuals, standards, guidelines, or whatever else would consistute attempts to predesign systems for unknown myriads of applications. Some proposals have been directed towards achieving EPA involvement. Based on extensive research and on-site experiences, it is asserted that no amount of new standards will replace rational judgment of on-site situations. New tools and education, rather than new restrictions, are needed. It is suggested that:

> 4. If the EPA provides guidelines for non-proprietary, on-site wastewater disposal systems, only general, positive, and practical guidelines would be of general benefit. Restrictive guidelines, unless based on well-established scientific fact, and unless needed to be presented, would best be provided by local authorities. Criteria for OSWMDs would be an example of positive guidelines.

Qualification of Proprietary Devices

There is no governmental agency adequately funded and charged with responsibility for qualifying proprietary on-site wastewater disposal devices. A non-profit but still private business, supported by industries having devices tested, could not be believed by everyone to be genuinely independent of its sources of revenue.

The rapid development of proprietary devices for on-site sewage management has far surpassed the ability of local authorities to judge each. Thus, there is an immediate need for a governmental organization which by laboratory and real field tests, describes attributes of proprietary devices. From published data, local authorities could then judge matters for themselves. Objectivity, contrary to some beliefs, would be enhanced by avoidance of provisions of standards, seals of approval, wall plaques, or other symbols of acceptance, constituting what ultimately must be arbitrary goals to be achieved.

Perhaps a governmental agency could be governmentally funded (to provide job security), industries with candidate devices could be charged for services, and those monies could be diverted to other areas such as to render the governmental organization as insensitive as possible to influences of interested industries. At the same time, a forum for outside scientific input should be provided.

The need is now. But input from industries, local authorities, engineers, and scientists should be had before a full program is set forth. A pilot program might be first in order.

AN OVERVIEW OF NEEDS

Disproportionate EPA Support

About 29% of the all-year-round housing units in the United States are served by on-site wastewater systems, mostly septic tanks. At the same time, the EPA's Wastewater Research Division has spent 6- to 8-million dollars on studies oriented towards public sewerage, and only $793,000 last year on on-site wastewater technology. Roughly 29% of our citizens received 10% of the monies spent searching for answers to problems.

Towards satisfaction of first needs, the EPA has granted huge sums of monies in support of public sewerage projects. Without a chance of direct self-benefit, a taxpayer not served by a public sewer subsidized his sewered neighbors. At more than one public meeting, someone served by a septic tank said, "How come I am buying sewers for somebody else? I pay taxes too!"

> 5. The EPA would seem well justified to spend far more monies in research and development of technology of on-site wastewater treatment than it has in the past.

Complexities of Technology

Although impressive in hardware, the public sewerage system is technically simple. Most persons grasp the concepts readily and successful systems can be predictably designed. In contrast, on-site situations pose a myriad of complexities. Few people understand the functions of the most common device, the septic-tank system. And, successful systems cannot always be predictably designed.

Too Few Seasoned Scientific Authorities

People knowledgeable in on-site technology know that there are at most, a handful of seasoned scientific authorities. And, fewer yet are scientific authorities who are at home in the practical world.

Essentially, any rapid evolvement of OSWMDs could not be staffed by fully prepared personnel. If universities chose to educate in on-site technology, there are no trained teachers or even an adequate textbook. More yet, not all research developments have been reported, time to write them up being needed.

> 6. There is an immediate need for a textbook approach to on-site wastewater treatment devices, with special emphasis on subsurface disposal fields. The book should be written by a recognized, practical authority.

Creative Scientists Are Needed

In dispensing public monies, government needs justification for choices of expenditures. When building a bridge, for example, firm understandings before projects are begun are proper. Creative research, however, cannot be purchased as would a bridge. Researchers have no way to know beforehand where understandings of the unknown are to be found. They only can direct and redirect as data are collected.

It is common knowledge that acquisition of EPA support for research requires more skills than likely to be had by creative researchers. At least one nationally recognized authority testifies to the situation. Universities and other research businesses employ professional proposal writers. There are courses in grantsmanship. And, it is well understood that proposals for projects with predictable outcomes are more likely to be funded than perhaps more imaginative proposals. As a result of such matters, some creative scientists may not be available to the EPA, and thus to serve the public. Also, some research programs tend to be not more than enlargements of past, known works. Corroboration of knowledge is worthwhile, but that is not the entire reason for repetition.

> 7. There is a real need to view creative scientists as national resources and put them to work with as few aggravations as possible. Of course, not every creative scientist is known, but some have a discernible track record.

Complexities of Communications

A child's game is each in turn, whispering a message in one another's ear. Initial messages and end results rarely match. For such reasons, lawyers respect rules of hearsay. Governmental processes, however, suffer such chances of miscommunications. The pyramid descends: from Federal, to State, to county or township, and finally to the individual on-site situation. Each level has its own pyramid, and regional arrangements may be inserted. Universities constitute an interesting side branch in that communication pyramid. The grant process has caused development of relatively direct lines of communications between researchers and liaison staff of funding agencies. But, university researchers generally have poor communications with the on-site sewerage industry. University researchers and practical fieldmen simply do not communicate in the same language. That, in part, contributes to a time gap between research findings and practical applications.

8. There is a need for top-level, decision-making governmental authorities to confer with nationally recognized, practical, scientific authorities on on-site wastewater systems.

Such a conference, or conferences, needs to be as informal as possible, with as few participants as are genuinely needed, and with adequate time to explore individual thoughts.

CENTRALIZED MANAGEMENT OF SMALL PLANTS

*John L. Fripp, Jr.**

The Georgia Department of Transportation is very much involved in the functions associated with the operation and maintenance of numerous and diverse small wastewater treatment plants.

At this time, we have eighteen small plants operating, to treat wastewater being generated from the same number of safety rest areas located on Georgia's interstate highway system. Some of these are located up to three hundred and fifty miles apart.

When our interstate highway safety rest area program is completed, it is anticipated that the Georgia Department of Transportation will be operating and maintaining thirty-eight small wastewater treatment plants for fifty-one safety rest areas. Some of the safety rest areas will be served by city or county wastewater treatment systems.

These small wastewater treatment systems range in capacity from fifteen to forty thousand gallons per day.

The small capacity plants consist of septic tanks, the effluent of which is dosed to sub-surface sand filters and the effluent chlorinated. There are four of these that have been in operation for about ten years with very satisfactory service.

Ten plants consist of activated sludge primary treatment, followed by secondary treatment polishing ponds and chlorinated effluents. These have been operated for four to six years.

In addition there are four activated sludge plants which are furnished with rapid sand filters for secondary treatment. These have been in operation for a period of one to three years.

Obviously, if each of the eighteen wastewater treatment plants were managed independently of all others, the cost effectiveness of the entire system would be questionable.

All treatment plants are required, by Public Law 92-500 as administered by the regulatory agencies, to restrict the pollutants in our discharge to what have been acceptable levels, and what will soon be even lower levels of pollutants. It follows, then, that operation and maintenance levels of performance must be regulated by management in order to insure operation within the legal limitations imposed upon us all.

Good management requires that sound judgment be applied to the use of resources to accomplish a goal. Recognizing that the goal is the continued, uninterrupted service provided by a wastewater treatment plant, we next should acknowledge that the resources consist of *many* things, much more than money. If good management is applied to all resources, then the amount of money required should be reduced. This should be particularly true when multiple plants are constructed and managed by a central agency, whether a city, county, private industry, or State agency.

There are at least six major areas to consider in constructing and successfully operating one, or many, small plants. The same management policies should be applied to all six of the following development processes:

1. Selection of engineers to determine needs and treatment process
2. Construction Phase
3. Select and provide a plant operator
4. Provide for laboratory testing
5. Maintain lines communication between regulatory agency, management, laboratory and operator
6. Exercise balanced fiscal policy.

Let us take each of the before mentioned items and examine them in more detail in order to more clearly define management's role:

1. *Selection of Engineers:* Just as with individuals, no two engineering firms have equal experience, skills, capabilities, work loads, and particular abilities.

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Atlanta, Ga.

The selection of an engineering firm should be done after a preliminary investigation of several engaged in providing the services required. This selection for a specific endeavor can mean the difference between a well-planned, low cost, successful project or a costly, partially successful one.

The firm selected should have successfully designed and supervised construction of plants of approximately the capacity, treatment function and degree of treatment that will meet the requirements of the project.

2. *Construction Phase:* The engineer who designed the facility should represent the owner during construction. The manager should maintain close contact in order to become familiar with the components of the system, if he is not already. Once the construction is completed and the engineer's services are fulfilled, then it will be necessary for the manager to communicate with the regulatory agency, the testing laboratory, and the operator. This will require a knowledge of treatment plant nomenclature and at least a basic understanding of the design process.

3. *Select and Provide a Plant Operator:* In Georgia it is required by State law that a plant be operated under the supervision of an operator who has been examined by a State board of examiners and certified as a wastewater treatment plant operator.

Management must usually provide for the necessary training of operators and for their helpers. Management should always make provision for uniformity of testing procedures and for a program of operation and maintenance of mechanical equipment.

It is an unwelcomed bit of information, to most people, to learn that waste treatment plants are not automatic in operation and that it is necessary to provide for a treatment plant operator's good judgment to the system. This is an absolutely necessary component of any good waste treatment system.

The personnel requirements should be considered at the same time that the treatment process is studied. The two are inseparable because the complexity of the treatment plant determines the necessary qualifications of the operator.

For example, when a septic tank with a subsurface sand filter is being considered in design, then it is generally recognized that land area requirements and construction costs are higher. It should be equally important to note that maintenance and operation costs are lower than for similar sized activated sludge treatment plants. Energy costs are lower than for similar sized activated sludge treatment plants. Energy costs are lower and the time and attention required of a plant operator is considerably reduced. Not all wastewater treatment problems can be applied to this type of system, however, because flexibility is limited.

When an activated sludge treatment system, of the intended aeration type, is utilized, then capital improvement cost might be reduced but operation and maintenance costs are increased. A more knowledgeable plant operator is necessary in order to maintain effluent quality with non-uniform flows and strength of sewage.

These are basic considerations in balancing the waste treatment system with operations and maintenance budget limitations.

When multiple treatment systems are centrally managed, as with the Georgia Department of Transportation, then the operating personnel cost may be divided over several plants. This is particularly true when the geographical area in which the plants are located is small.

As with all livelihoods, the salary requirements for plant operators increase with skill and experience. The degree of technical expertise, along with a desire to do a good job by the plant operator does affect the performance of any waste treatment plant. The level of performance required of the operator must be balanced with the complexity and level of performance required of the plant.

Cutting operating cost by providing lower paid unskilled personnel is false economy. The resulting higher equipment operating cost due to misuse or poor routine care can more than offset the savings in salary cost. Then, too, maintaining the pollutant limits of the plant effluent is usually not achieved consistently, sometimes resulting in more capital outlay being required in an effort to improve the teatment process.

The selection of a plant operator is no less important for limiting the discharged pollutant levels than the selection of the plant treatment system, although it is rarely considered in this way.

4. *Provide for Laboratory Testing:* The effectiveness of the treatment process must be monitored in compliance with regulatory agency requirements. This requires certain laboratory equip-

ment and skilled personnel. We are fortunate in that we have available good laboratory facilities and skilled personnel to perform the necessary testing.

The results of the test (five day bio-chemical oxygen demand, suspended solids, fecal coliform, dissolved oxygen, pH, and chlorine residual) are reviewed each month by the operator, the regulatory agency, and management.

Where deficiencies exist, corrective measures are undertaken.

Composite samples are obtained and laboratory analyses are performed once each month, by Department laboratory personnel, on thirteen of the eighteen treatment plants. The average yearly cost of this monthly service is approximately twenty-two hundred dollars for each plant.

5. *Maintain Lines of Communication:* I have little doubt that this is one of the most difficult jobs that management has. It is one of the most important.

If the operator does not see the results of the test until a month later, it does him little good. Communication must be swift and concise or the treatment process accomplishes far less than designed for.

6. *Exercise Balanced Fiscal Policy:* The importance of placing the same level of consideration on the operation and maintenance of the small plants as is placed on the design and construction of them is often ignored. One reason for this is that during the design and construction phase, too little is said about the cost of operation.

One of the responsibilities of the designing engineers is to evaluate the operating cost of the treatment process selected. This information should be brought to the attention of management, and the necessity of budgeting for equipment maintenance, repairs and replacement, even during the first year of operation, should be emphasized.

Energy cost, lubricant cost, chemical cost, the cost of safety equipment such as flotation gear, and self-contained re-breathers for use in handling chlorine gas, miscellaneous tools and electrical fuses, and the cost of operator test equipment should all be recognized and realistically budgeted for.

In a centralized management system, bulk buying at reduced unit cost should be taken advantage of and distribution made as required.

In summary, by applying the same successful management techniques to wastewater treatment plants, as is applied to most other areas of business or government, the best results can be obtained from our water quality control efforts.

OWPO POLICY

John T. Rhett[*]

I am very happy to join you in examining some new approaches to provide less costly wastewater systems for our smaller communities.

Since this session this morning will be wrapping up the conference, it is appropriate to summarize a few of your findings and to congratulate you as members and participants, for the very worthwhile contributions you have made to the exchange of information and ideas on our subject.

This conference came about because evidence is accumulating rapidly that many wastewater treatment facilities that have been funded or planned for funding through our National Construction Grants Program, are too expensive for the local population, particularly the small communities. During the past two days, you have been exposed to alternatives which may be more cost-effective in many instances than conventional sewering and treatment.

Our problem is that solutions such as the pressure and vacuum systems you have discussed, the cluster systems, land treatment systems, honey wagons, centralized management of small plants, and the like, do not currently belong to the lexicon of the centralized treatment planner. In order to gain acceptance and a full and fair consideration of such alternatives, our program policy is to call for a careful evaluation of all the viable alternatives in each situation. This evaluation requires that the economic impact on the families in the community be a significant consideration in the planning and these costs, both in capital and O&M, must be explained, in detail, at public conferences on the facility plans.

Often insufficient credit has been given in the plans to improvements that can be made to the operation of existing systems—for example, to the septic tanks. Please note that we are not trying to tilt the analysis toward bias in favor of small systems but rather toward a carefully balanced analysis of all the solutions to the local water pollution problem. As you know, previously the tilt has been against the small and innovative systems.

Whatever the alternative that is selected, it must of course, be environmentally acceptable and meet the requirements of the Water Pollution Control Act. It must provide best practicable waste treatment technology or some more stringent level of treatment, as required by standards for water quality, in-stream.

It should be noted that our definition of BPWTT includes a standard for protecting ground water, where planned disposal systems such as septic tank leach fields are used. It is a major concern to us that this is often misinterpreted to require that effluent must be of drinking water quality when disposed of on the land, or into the soil. The correct interpretation is that the effluent has to be of this quality when it reaches an acquifier that is presently being used, or may potentially be used, as a drinking water source. Common sense would suggest that local geographical, geological and climatic conditions should be capitalized upon where these are fortuitous.

My office of water program operations is taking a variety of steps to assure the costs are reduced, where possible, for small communities.

- We changed the secondary treatment requirements to eliminate disinfection, except where required by water quality standards.

- We are allowing for less stringent limitations on suspended solids from small treatment lagoons.

I cannot stress too strongly the benefits we expect from this allowance for the small town ponds. There are between 2,000 to 3,000 of these, and they provide generally adequate treatment without overly sophisticated or costly O&M.

- We are also requiring that facility plans present local capital and operation and maintenance costs in readily understandable form and that this information be presented at all public hearings on facility plans.

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The stage is set for the examination of lower cost alternatives by the people directly affected.

- We are modifying the cost-effectiveness guidelines to establish policies and guidelines that ensure cost-effective sizing and staging of treatment works. To ensure plans do not overestimate future growth:

- We are improving population projection criteria and guidance for estimating wastewater flow and treatment works size.

- We are improving the procedure for determining construction staging periods that are most cost effective.

- Finally, we are encouraging sanitary engineers, regulatory engineers and health officials to update design criteria, practices, and health requirements to take into account the new materials, new knowledge and accumulated experience.

This conference is one part of this educational, informational effort.

Most importantly, we are currently preparing guidance to our regions to emphasize that adequate consideration be given to low-cost systems, and to emphasize the eligibility of septic tank-soil absorption systems, or alternative systems serving individual homes and small clusters of homes. A copy of this draft guidance or program requirements memorandum, was included in the materials for this seminar. We are currently analyzing the comments we received and preparing the final directive. Until this is completed, the draft memorandum you have represents the policy of the agency. Basically, this policy is that on-site systems serving clusters of two or more homes are eligible for grant funding, if they are State approved and certified projects. Certain minimum standards must be met:

1. A project must be the most cost-effective that will meet local conditions and satisfy State and Federal requirements.

2. A project must be owned, operated, monitored and maintained by a municipality.

3. The facility must be located on public property, except where easements will suffice, such as for installing sewers, providing access to and maintenance of facilities located on private property.

4. Secondary treatment or some more stringent level required by water quality standards, must be the minimum, if the effluent is to be discharged into our waters.

5. Septic tank leach fields or other land disposal techniques must meet local, State and Federal groundwater and public health criteria.

6. Vehicles and associated capital equipment required for servicing of the systems are also grant eligible.

I will be specific on this point:

- Vehicles purchased under the grant must have, as their sole purpose, the transmission or transportation of liquid wastes from the collection point (holding tanks) to the treatment facility. Neither general maintenance vehicles, nor other types of vehicles are allowable for grant participation.

One of the major causes of septic tank failure is the lack of regular removal of septage.

I would like to emphasize that septage treatment systems and vehicles purchased, as I just described, to serve a group of individual family systems are eligible for 75 percent Federal grants.

Also, by this time, you should be advised that current Federal regulations specifically recognize pressure sewers as grant eligible collection systems. These regulations define the area of eligibility to include pumping units and pressurized lines for individual structures or groups of structures. This is when such units are cost-effective and are owned and maintained by the grantee.

Where the planner does not consider the alternatives we have been discussing, his project will be turned down during State or EPA regional review. We are pleased to see that projects, such as those for the bay-to-bay sanitary district and for the Southwest Lincoln County, both located in Oregon, were disapproved. Disapproval was based on the judgment that the planned sewering was unwarranted and truly cost-effective alternatives were overlooked.

We are also pleased to see communities such as Apple Valley, California, defer costly conventional sewering and consider a septic system inspection and maintenance program.

We particularly want alternatives to be assessed without regard to eligibility for Federal funding.

For this reason, we are extending the use of facility planning grants to consider carefully the alternatives which may or may not be eligible.

Some project costs are, of course, unavoidable due to construction inflation, adverse soil and climatic conditions, or stringent water quality standards requiring advanced waste treatment. Where relief is essential, EPA at this time is primarily dependent on publicizing additional financial support available from other Federal agencies such as Farmers Home Administration.

To assist municipalities in raising the local share at reasonable rates, the recently passed Loan Guarantee Law will soon go into effect. Under this law, loans from the Federal Financing Bank to finance the local share will be guaranteed by EPA. Interest rates will be set by the bank and should approximate the Federal borrowing costs, plus a fee for servicing.

I have some thoughts in summary. Under certain conditions smaller, less costly, wastewater treatment systems, servicing equipment, and residential waste disposal facilities are eligible for EPA grants, where they are cost-effective. Insofar as new installations are concerned, the law and the regulations impose no restrictions on types of sewage treatment systems. Septic tanks and absorption fields, holding tanks, package plants, pressure systems, and so forth, are all eligible for funding when projects are State approved and certified and where minimum standards are met and two or more homes are served. Use of small facilities may reduce capital and O&M costs. They may also reduce the need for highly-trained operators which the sophisticated systems generally require. Small communities have difficulty in finding these operators and even more difficulty funding them.

We hope this conference has been of value. We appreciate your help towards cleaning up our nation's waterways, and if this conference has provided you with more capabilities toward this end, then it has been a success.

Call upon us at any time if you have questions or need assistance.

208 PROGRAM

*Joseph Krivak**

For the past two days, you have heard a number of horror stories about the economic impact of conventional wastewater collection and treatment systems in small communities. This topic unquestionably will continue to be highlighted and will receive continuing attention by EPA regions, States, local communities, and consultants. It is of course long overdue attention.

Let me provide you with a short quote from a report on the subject which I looked at a few days ago. It was a report from a symposium—such as this. It identified a number of problems as follows:

- The absence of clearly established responsibility for planning and provision of services.
- The absence of clearly established responsibility for risk-taking and development investments; and
- The absence of adequate procedures for coordination.

The symposium was held by the Institute of Government on Better Water and Sewer Services for Small Communities. And it took place ten years ago.

While we are beginning to concentrate on this new found interest in facility planning, we should keep in mind and use the data-analysis and planning which is currently underway under Section 208.

There is little doubt that Congress had this issue in mind when Title II of the FWPCA was written. While the program details were not spelled out, the language in the act certainly provided the concepts and the direction we should take. Language in both Section 201 and 208 calls for consideration of the full range of alternatives to meet cost-effective requirements, environmental standards and social-economic objectives.

Four years later, how well have we done in 208 planning to carry out the mandates set forth in the act?

While 208 is often seen as a complex section of the act, it becomes less so when you focus on the purpose behind each of its elements.

In respect to wastewater systems for small communities, the objectives of 208 are clear:

(1) The recognition that elected officials of local government assume a major policy-making role in the 208 effort. At the community level, the public policy questions in balancing management of growth, deciding who benefits and making decisions on who pays the costs is as important as in the major cities.

(2) The requirement that management and implementation decisions be made as an integral part of the 208 process. You have heard enough speeches about plans on the shelf that it doesn't bear repeating.

If we needed any more evidence of the scope of the problem it has been provided to us by the 208 areawide agencies. As you know, there are now 176 areawide agencies funded—in addition to the work going on in each State. When we provided guidance to these agencies, we didn't ask them to do everything in the short time they had to develop a program, but rather to tackle the worst problems. It wasn't a surprise when better than 50% identified failing onsite wastewater disposal systems as a significant source of surface or ground water pollution.

The planning process is now well underway and plans are now starting to emerge. While only one plan has gone through the State approval process we have seen about a half dozen in draft stage. In some, the old style engineering view has prevailed. The agencies are primarily recommending central treatment facilities with related collection systems rather than the use of alternative cost-effective systems for onsite wastewater disposal. Alternative, efficient systems for onsite wastewater disposal were usually not investigated in the plans. In instances where the 208 plan indicated that the area contained a proliferation of onsite disposal systems, but a problem did not currently exist, little attention was given to any kind of an operation or maintenance program that could prevent potential future failures from occurring.

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The 208 planners as well as their consultants are looking at onsite wastewater disposal systems in the traditional manner, mainly as short term interim systems that will be abandoned as the central treatment plant and collection system is extended further into rural and suburban areas. This philosophy does not take into account the economic cost of collecting and treating municipal wastewater. The simple fact is, as this meeting so succinctly brought out, that many smaller communities cannot afford the luxury of a central treatment system. The alternative is to make the present system work through implementation of 208 plans. Wastewater management agencies can be created at the State and local level that will administer programs to regulate the design, installation, operation and maintenance of onsite wastewater disposal systems through licensing, certification, bonding requirements and inspection permits. Let me quickly spell out some of the findings and recommendations which are representative of the reports:

- Unsuitable conditions for subsurface wastewater disposal.
- Lack of maintenance and repair
- No inspection once installation is completed
- Detection of violations depend primarily on citizen complaint and occurs only from most glaring problems.

You will note that the majority of the issues are not technical—but institutional—legal problems. So it is not surprising that a major emphasis of the 208 plan recommendations and need for action is not laying out systems of control but calling for management and maintenance systems to tackle the tough political and regulatory issues.

I believe the 208 plans provide a sound basis for facility planning. They will not and are not designed to be the decision for the technical-financial-management details. While I've expressed an optimism for the results which will come from the 208 process—all is not rosy. There are many hurdles to cross over before we have a sound national program for small community systems. While our *policies* are now or will soon be in a position where we will permit certain things to happen, our *programs* must be developed so they encourage and are responsible for these actions taking place.

The following points will be important in developing a program which will be responsive to meeting public needs from an economic, social acceptance and environmental standpoint.

(1) Do not spend time on reinventing the wheel. 208 planning has or will have laid a sound framework for small community systems in many areas. Funds for facility planning should not be used to restudy the same issues. In few cases, if any, should population projections be restudied. By and large, problem identification and analysis will have been studied in sufficient depth to make the decisions which will be required without spending money and wasting time on another similar exercise.

(2) The agency/States/local communities must demand a change in direction in facility planning in many areas. Conventional systems—such as those you have heard about in the last two days and which wasted time and money to design must be nipped in the bud at the earliest stage of planning as possible. I'm not saying that small community systems will provide all of the answers and we abandon everything else. I am saying that we truly look at all alternatives, without prejudice of long dead engineering or social acceptance values.

(3) Both public and private sector must look closely at the kind of expertise we are utilizing. It may be quite different than what we have used in the past. I don't know if there will be any need for recycling of engineering expertise. I do know that a different mix of know-how is needed if we mount a truly national program. The institutional and management problems will be significant. Since many of the projects will involve communities with little or no history of providing services to their constituents and the likelihood of that infrastructure developing quickly is not high, the role of EPA, State government and the private sector will be very important.

(4) Someone—a public agency—will have to provide hands on assistance to a greater degree than ever. I'm not sure where this comes from—or even if it exists in the form required at the present time. EPA doesn't have it. Most states don't have it. Risk capital may be required to get the private sector involved.

(5) Better coordination at the Federal level will be needed. This involves more coordination within EPA—more coordination between EPA and other Federal agencies. In most cases, the same need for coordination exists at the State level.

(6) More attention must be paid to the common issues, concerning water supply and waste dis-

posal. Many small poorly managed water services co-exist in the same areas with malfunctioning septic tanks.

- Upgrading of supervision and regulation of small community waste disposal systems must consider the water supply systems. EPA has major responsibilities in both areas and must decide how best to coordinate its authorities and programs.

In summary, the policy decision which will let us get on with the task of helping small communities to develop reasonable wastewater systems solutions has been made. The planning done under 208 can provide a good start for facility planning in many areas. All of the tools we need are available – if we know how to use them.

STATE PERSPECTIVE – FACILITIES PLANNING FOR SMALL UNSEWERED COMMUNITIES IN ILLINOIS

*James R. Leinicke**

The State of Illinois has some 880 incorporated communities of less than 2500 persons. Until the advent of the construction grants program for sewerage facilities, most of these towns were unsewered, with sanitary needs being met with septic tank systems. These septic systems were frequently poorly designed, installed, and maintained. Encouraged by State and county regulatory agencies, most of these towns have applied for Federal grant funds to solve their sewerage deficiencies.

In many cases, this cure has caused more problems for our streams than were the malfunctioning septic tanks. The financial resources for operation and maintenance of treatment plants are low in these communities, and treatment plants frequently perform far below their intended efficiency. Our Agency has attempted to alleviate this problem by encouraging the use of relatively simple types of treatment plants, such as lagoon systems for towns of under 2500 persons. Unfortunately, as ever stricter effluent and water quality standards have become effective in Illinois, even lagoon systems have become complex, and costly. With large numbers of small unsewered communities coming into priority for Federal Step 1 grants, we began to realize that the conventional solution to wastewater disposal problems in unsewered communities, which up to that time was build a sewer system and treatment plant, was no longer within the financial capabilities of many communities, even with grant assistance.

This concern was given impetus by our experience in our own State grant construction program.

Prior to the time when most small communities came into priority for Federal Step 1 grants, the State of Illinois pulled a number of them out of the Federal priority list for funding with State money in a separate grant program. Our State funded grants program, which was terminated in July, 1976, was identical to the Federal program, but allowed the State to get a number of projects under construction for which we felt there was a pressing need irregardless of their low Federal priority. Among these were quite a few projects for small, unsewered communities which had been certified by State health officials as having a serious public health hazard as a result of malfunctioning septic systems. Under the State program, quite a few of these communities went all the way to construction before we began to receive facilities plans for similar towns on the Federal priority list.

This State program gave us an opportunity to evaluate the economic effects of this type of sewerage project on a small town. Towards the end of the State program, we made a study of some 23 unsewered communities of under 1000 persons which had let bids for a new sewer system and treatment plant, mostly lagoon systems. The results of this study were disturbing to us, particularly as we had begun to receive indications that some of these towns had seriously over-extended themselves financially to fund the local share of their projects.

Our study revealed the following information about costs in these 23 communities as they existed at the time of plant construction:

1. The average total project cost, less O&M and interest, was $1552 per capita, or about $4600 for a household of three.

2. The actual local share for a typical small town project consisting of collector sewers and lagoon system with filters for algae and disinfection facilities amounted to 43% of the total project cost. The average local share cost per capita was $631.00, or about $1900 per household of three.

3. Roughly 61% of the total project cost was for the collection system.

4. The total project costs averaged 110% of the 1974 assessed evaluation of these communities. The local share cost of these projects averaged 42% of the 1974 assessed evaluation.

Carrying this one step further, we assumed the minimum possible annual O&M cost for this type of treatment system, roughly $7000.00 per year, and calculated monthly user charges for the two most common types of local share financing then in use – an FHA loan at 5.5% for 40 years and conventional financing at 7% interest for 20 years. The average monthly user charge using the FHA figure was $15.64, while the average monthly user charge

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with the 20-year 7% loan was $19.36. Although calculated using some conservative assumptions, these costs are high, particularly when applied to small rural communities.

Along with our concern over the costs of conventional sewerage systems, we also began to seriously question their cost-effectiveness. Obviously, some of these small unsewered towns had serious, widespread problems with septic systems due to poor soils, water supply by private wells, and other factors which seemed to indicate the necessity of a sewer system despite the cost. However, many of these towns applying for Step 1 funds had a much less obvious need for such a system. Septic tank malfunctions were scattered, and, while highly visible and frequently a nuisance, were not clearly causing stream pollution, and often were few in number compared with the total number of systems in the community. It became obvious to us that in many unsewered communities correction of individual malfunctioning septic systems would have to be far less costly than a new sewer system.

Our Planning Section first suggested that facilities plans seriously address the continued use of septic systems as an alternative to conventional sewerage projects in 1975, but failed to find support for the idea within our own Agency. The general feeling at that time was that a Step 1 plan of necessity should point the way towards a construction grants project, and a policy favoring on-site disposal ran counter to that goal. However, in the following year, evidence that a less costly alternative to a conventional system was needed continued to grow. Finally, U.S. EPA provided us the mechanism we needed to establish a new policy in the form of the "No Action" alternative requirement in planning. As conceived, the "No Action" requirement was literally a requirement to examine the actual effects of foregoing a construction project to maintain the status quo. We interpreted it broadly as giving us license to require examination of a wide range of unconventional approaches to sewage disposal in unsewered communities, including continuance of some type of on-site waste disposal, either with or without some sort of construction grant project. As such, our concept frequently required a good deal of action on the part of grant applicants.

In the spring of 1976 we began requiring an examination of the so-called "No Action" alternative in newly submitted plans for unsewered communities, with very unsatisfactory results. For decades, the whole thrust of sewerage improvement in Illinois, indeed the nation, had been away from individual septic systems and towards a modern, centralized sewerage system for every community. Policies encouraging sewer systems over septic tanks were reflected in State and county septic tank regulations, and in numerous State position documents. Quite naturally, most Illinois consulting engineers failed to take the "No Action" requirement seriously, viewing it as an additional piece of Federally inspired red tape that did not have State support and requiring only cursory treatment in facilities planning.

Consequently, throughout the spring of 1976 we received many facilities plans for small unsewered communities which dismissed the whole issue of continued use of septic systems by statements to the effect that septic tanks were unacceptable for use in the area due to poor soil conditions, high seasonal ground water, or some other cause. Virtually no one documented these conditions or provided a cost-effectiveness analysis. More disturbing, the universal assumption was that a lack of a sewer system automatically meant a stream pollution condition existed, again without documentation. A number of these communities were towns with which IEPA personnel were familiar, and in many instances we were positive that there was no water pollution occurring.

It was at this point, in the summer of 1976, that our Agency decided to commit itself to the serious examination of the "No Action" alternative for unsewered towns of under 1000 persons. We had two goals in mind:

1. To determine in the Step 1 process whether or not a water pollution problem actually existed which justified a community sewerage project, as our priority system had apparently failed to perform this function adequately;

2. To attempt to find less costly means of meeting the legitimate needs of a community other than the traditional sewer system and treatment plant. It was our hope that if a facilities plan could not justify a Step II and Step III grant for a sewerage project, it could still serve as a worthwhile document for use by the community in correcting its problems on a local level. This seemed increasingly important in view of the fact that many plans were recommending a conventional system with no other options, and the communities were unable to raise the necessary local share funds to proceed with the facilities plan recommendation.

In response to these concerns, IEPA drafted a set of basic guidelines for the examination of the "No Action" alternative for small, unsewered communities, and mailed them out to every consulting firm known to be doing sanitary work in the State, and to every regional planning commission. We also adopted these guidelines as a standard attachment to our application package for a Step 1 grant.

The guidelines contained several basic parts:

1. The guidelines required that when either stream pollution or a public health hazard is alleged to result from malfunctioning septic systems, the facilities plan must provide specific documentation of the nature and extent of the problem.

2. As an extension of this, the plan must document the nature, number, and location of septic tank mal-

functions. To achieve all of this, the guidelines recommend a community survey of every individual disposal system, to be carried out by local officials or their consultant.

3. The guidelines require that in cases where poor percolation rates and high ground water conditions are alleged as factors limiting the usefulness of individual on-site disposal systems, these conditions will have to be documented by percolation tests and soil borings.

4. The guidelines require that in any analysis of the "No Action" alternative, a technically feasible proposal for meeting the needs of the community by some means other than a new collection system and treatment plant should be made, and its present-worth cost compared to the present worth of the most cost-effective conventional system.

5. Because the use of individual septic systems in Illinois is regulated by a separate Agency, the Illinois Department of Public Health, we included in our guidelines several minimum conditions which under IDPH regulations must exist before new individual septic systems of conventional type can be built. These exclusions, however, do not rule out the more sophisticated types of on-site disposal systems.

6. We required that where applicable, facilities plans must examine alternatives such as a limited service sewer system to serve a portion of a community. For example, in many small towns septic systems work very well except in one isolated area, such as the business district where open space for adequate on-site disposal is not available.

7. Finally, we required estimated monthly user costs be clearly spelled out for each alternative in the facilities plan.

Reaction to the issuance of these guidelines was quite pronounced. In drafting them, we were very much aware that our own knowledge of how this issue should be approached was limited. However, in sending out the guidelines our intent was not so much to give the last word on how the subject should be approached so much as to get the attention of the consulting world. In this respect they were successful. The guidelines by no means had the universal support of our own engineers, many of whom felt that the entire concept was too radical a departure from established practice. The initial response to the guidelines was split between strong support, generally from the planning community, to strong dislike, generally from the engineering community. But all parties immediately began offering constructive criticism which in a matter of a couple of months considerably modified the actual manner in which these guidelines are applied. We decided, for instance, that most of the theoretical business of soil types, etc., was not really too relevant in determining whether continued use of on-site disposal systems was viable. In Lake County, for example, published soil studies indicate some of the most unfavorable soil conditions for septic systems in the entire State. However, a vigorous and innovative county health department makes systems work in that area. In contrast, many areas of the State where favorable conditions predominate have a wide incidence of septic system failure.

Finally, we de-emphasized many provisions of the guidelines in favor of the community survey, intended to accurately determine existing conditions. We felt that realistically these constituted the best indicator of the feasibility of on-site disposal in a particular area. In practice, virtually no one has been required, for example, to do percolation tests or soil borings, but we have insisted on good surveys.

To help implement this phase of the program, agreements were reached with Region V of U.S. EPA so that existing Step 1 grant offers could be easily amended to pay the additional costs of the community survey and an in-depth analysis of "No Action." We also prepared a sample questionnaire as an aid to communities in their surveys.

The results of this type of survey have been interesting. Almost the first communities to carry it out were six small towns in the central part of the State, all concentrated in one county. A single engineering firm had submitted almost identical facilities plans for the six communities. All the plans dismissed septic systems as being unworkable due to inadequate soils, alleged the existence of water pollution, and indicated enthusiasm on the part of the citizens for the proposed sewerage project, which in every case was a collection system and multi-cell lagoon system.

We required a community survey in each town. The results may be typical of those we will see throughout the state. Of the six towns, three were found to have no identifiable stream pollution resulting from septic systems, and few individual system malfunctions of any sort. Furthermore, the citizens of these three communities when polled were found to be strongly opposed to a sewerage project, and were under the impression that it was being forced upon them by the State and Federal Government. We had only received a hint of this attitude in the public hearing minutes submitted with each plan.

In the remaining three communities, one town had no identifiable needs, but the citizens favored a community sewerage project, apparently in hopes it would be a worthwhile community improvement. Only one community had a clear, widespread need for a conventional collection system and treatment plant, as well as community support. Not surprisingly it was the largest of the six. The last town had needs, but little public support for a sewerage system. However, it appears that these needs may be met by a project which does not involve construction of a complete sewerage system.

Six small communities where facilities planning had called for a conventional sewer system and treatment plant, and upon close analysis, only one such system was justified. In only two communities did the people even want such a project. We believe that such results may ultimately prove to be typical of much of the State.

Our application of this program has had some notable successes, but has also pointed out some serious problems. On the plus side we have seen a number of facilities plans for communities currently served by septic tanks which discharge to an existing small diameter village tile system. In the past, our Agency would have insisted that a new sanitary sewer system be built. We are now allowing the continued use of such systems with only the addition of a lagoon system to treat the tile discharge. This departure from our past policy was made with strong reservations in some quarters of our own Agency, but seems justified in that even with tile improvements as much as 50% of the cost of a conventional project can be saved by this approach. A number of communities are going ahead with this sort of project.

We have just reviewed a facilities plan proposing new on-site disposal systems to serve clusters of homes. In this case, the disposal systems will be municipally owned and operated, constructed on easements obtained from property owners. This alternative appears to be very cost-effective, allows for much more sophisticated disposal systems than are normally associated with single residences, and is eligible for grant funding under the present rules.

We are very pleased with these successes. However, we also have discovered some serious problems. One of the most basic difficulties we have encountered is a general lack of expertise within our Agency and within our State's engineering community in regard to on-site disposal. This is not surprising in view of the many years of official discouragement towards this approach to waste treatment. In Illinois, the officially recognized and widely known methods of on-site disposal are the conventional seepage field, the seepage bed, and the buried sand filter. Newer developments, such as the Wisconsin mound, are virtually unknown. Along with a lack of expertise goes considerable mistrust for new approaches, and this mistrust extends to such developments as pressure and vacuum sewer systems. Without experience with these newer types of systems, our consultants are reluctant to recommend their use and our own engineers are even more reluctant to approve them. We believe that there is a tremendous need for an effective, national clearinghouse of information on this subject, along the lines proposed by Senator Randolph. The clearinghouse should report all developments and experiences in this field, whether resulting from a Federal research project, developments in the private sector, or actual experiences in the States. Without a tremendous effort in education in this field, we are simply not going to be able to overcome the widespread bias against these approaches to wastewater treatment to the degree necessary to have a wide impact on future sewerage practice.

Another serious stumbling block is the present lack of eligibility for on-site systems serving a single residence. In many instances, the total cost of upgrading individual systems in a community appears to be far less costly than a conventional sewerage project, but perhaps more than the local share cost of the conventional project. In such an instance the cost-effectiveness of maintaining single residence disposal is not too obvious to the local officials. The people who have to bear the costs in that alternative are frequently those who can least afford it. This dilemma has been the single most significant problem we are facing. Since we don't have a solution, we have advised many of these communities to delay the completion of their plans until we see whether or not and under what terms the government might provide financial assistance to upgrading individual systems.

In addition to providing a national clearinghouse for new technology and extending eligibility to upgrading single residence disposal systems, we believe there are a number of other steps which the Federal government could take to aid the states in successfully applying this program. One obvious field of assistance is in the development of new technology. Some areas where support is needed are:

1. Development of satisfactory "low" water or no water plumbing fixtures for residences.

2. Development of "dual pipe" plumbing which separates grey water and black water flows, with the grey water being put to beneficial uses.

3. Development of new types of economical and environmentally desirable on-site disposal systems for use on marginal soils and small city lots.

In addition to expanding grant eligibility to single residence systems when municipally owned and operated there are other financial incentives that might be provided to encourage on-site disposal:

1. Consider making the construction of public water supplies grant eligible where the elimination of private wells might make the continued use of septic systems feasible.

2. Expand funding to research and development grants for innovative and inexpensive disposal systems and for the management tools necessary to make them effective.

3. Fund demonstration grants for new types of on-site disposal systems throughout the country to reflect differing regional conditions and requirements.

4. To promote improvements to residential disposal systems in areas where direct local government control of facilities is not feasible, make low interest loans or tax deductions available to homeowners for the improvements.

5. Provide greater support for research and development outside the Federal sector, including research and development by industry in this field.

6. The government could encourage innovative projects by offers to piggy-back Title 2 grants with demonstration grants to pick up the local share cost. The present system discourages small communities from innovative and therefore high-risk projects due to the substantial investment they must make in the system.

7. Finally, the Federal government and the States must recognize that the success of this apporach to waste disposal relies heavily on an intensive, highly individualized approach to facilities planning on the part of consultants. "Cookbook" solutions will not suffice if maximum dollar savings and environmental compatibility are to be achieved. What this may mean is a substantially more detailed and costly Step 1 effort, as the consultants will have to be paid enough to make a highly individualized facilities plan profitable for them, even if a major construction project does not result from their efforts. The potential savings in public money by eliminating unnecessary conventional sewerage projects are tremendous, as has been pointed out at this conference. A greater Step 1 investment to achieve this goal seems to be sound business.

We are hopeful and enthusiastic about the potential economic and environmental benefits of decentralizing wastewater disposal in small towns. Before we will enjoy a great deal of success, however, this aspect of sewerage practice has a great deal of catching up to do with the tried and accepted centralized systems. We in Illinois will continue to support this program as much as we possibly can, but if it is really to have a significant impact on wastewater practice, then all its aspects; technical, financial, and managerial, must receive at least as much, and in many ways more support from the Federal government than has been given in the past to conventional methods of wastewater disposal. We are now in the very midst of the problem, and that support must be massive and immediate.

GUIDELINES FOR EVALUATING THE "NO ACTION" ALTERNATIVE IN SMALL, UNSEWERED COMMUNITIES

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF WATER POLLUTION CONTROL

To aid in the preparation of facilities plans for unsewered communities of less than 1000 population, the Illinois Environmental Protection Agency has prepared guidelines for use by consulting engineers. U.S. Environmental Protection Agency regulations require that all facilities plans examine the "no-action" alternative, which for unsewered or partially sewered communities includes examining the cost-effectiveness of upgrading individual residential disposal systems as well as other alternatives which might meet the sewerage needs of the community short of an area-wide collection system and treatment plant.

The need for such an approach in facilities planning has been verified by engineering estimates demonstrating that capital and O&M costs for a centralized sewerage system in certain of these small communities are likely to be prohibitive. The costs frequently exceed the financial capabilities of the community. Adequate evaluation of the "no-action" alternative would, in these cases, at least result in a facilities planning document which could serve as a working plan for a community to resolve its individual wastewater problems if a community system were economically infeasible or non-cost effective. It is the intent of this Agency that all facilities plans contain some implementable solution to satisfy both community wastewater needs and water quality goals.

With this in mind, the following guidelines will govern this Agency's review of planning for small, unsewered communities:

Definition: Malfunctioning systems are generally defined as disposal systems discharging to farm tiles, storm sewers, village tiles, surface drainage ditches, ground surface, rivers, lakes, streams, or intermittent waterways. Included in the malfunctioning category are all cesspools.

A) No Action Alternative:

1) In cases where it is alleged that malfunctioning septic systems are causing or contributing to viola-

tions of Chapter 3 Illinois Water Pollution Control Regulations or provisions of the Environmental Protection Act, the applicant shall provide evidence in the form of stream sampling and discharge data, to support such allegations.

2) In instances where malfunctioning septic systems exist, but stream pollution cannot be clearly demonstrated, a health hazard may nonetheless exist. Any claim to such a condition must be supported by documentation from State, county, or local health authorities, citing specific conditions in the community.

3a) For either of case one or case two above, a community survey must be conducted to determine the number of residential disposal systems in the community, and the number, nature, and location of malfunctioning systems.

It is suggested that the following questions be answered for each residence:

1. How old is the septic system?
2. How often is it cleaned?
3. Any known surface discharges?
4. Any other malfunctions?
5. Lot size?
6. Is a garbage grinder connected?

Force account work may appropriately be used for the collection of this information providing prior Federal/State approval is obtained.

3b) Percolation tests shall be performed in the community, and the results included in the planning to determine the local soils' compatibility with septic systems. In general, a separate representative percolation test should be performed for each different soil type in the community. Percolation tests shall be performed in conformance with Rule 7.02 of the 1974 Private Sewage Disposal Licensing Act and Code (hereafter referred to as the 1974 Act) by the Illinois Department of Public Health (IDPH).

4) For either of case one or case two above, and based on the information obtained in the community survey and soil tests, an alternative to sewage collection and treatment shall be provided which specifically lists the capital costs and methodology involved in bringing all of the malfunctioning systems into compliance with IDPH regulations using any approved method listed in the 1974 Act, or by any other method which the consultant can support as being a workable alternative for that geographical area. To these capital costs may be added a reasonable estimate of additional capital costs to upgrade systems which may be currently functioning, but which, based on the community survey, may be expected to malfunction during the planning period due to old age or because the installation does not meet current IDPH construction or design standards.

The consultant shall list the total costs, for upgrading individual systems, and document the basis of the cost estimate.

An operation and maintenance cost shall be included for operation of septic systems which consists of pumping out the tanks not less than once in three years. More frequent pumping, up to once a year, may be justified for specific systems identified in the survey as requiring it due to garbage grinders, other unusual wasteloads, inadequate tank size, etc. The consultant may wish to analyze the desirability of regular septic tank pumpage as a municipal service, using municipal equipment. (The cost of such municipally-owned and operated equipment is eligible for grant consideration.)

The sum of the above costs will be regarded as the cost of upgrading residential systems, and expressed as present worth, may then be compared for cost-effectiveness with other alternatives, including a partial or complete sewer system and centralized treatment plant.

5) In place of the survey and percolation tests described in three above, where the following conditions can be proven to exist based on published soil studies, soil borings, and percolation tests, it may be assumed that the soil is unsuitable for *conventional* septic tank-tile field disposal systems, and that alternative may be eliminated from further consideration:

a. An overburden of less than 30' of soil over a creviced limestone formation.

b. The presence of the maximum seasonal ground water level, based on soil borings, less than 4' below the lowest point of a distribution field.

c. The presence of "fragipan" or other impermeable formations less than 4' below the lowest point of a distribution field.

d. Percolation test results in excess of 360 minutes for a 6" fall of water in the test hole.

6) In cases where it is shown that conventional residential disposal may not be suitable for a particular geographical portion of a community (for example, in an old business district where no ground is available for disposal fields and septic tanks

discharge to a storm tile), but the remainder of the community is suitable for septic tank service, the applicant should include an alternative of a limited collection and treatment system.

B) Sewage Collection and Treatment Alternatives:

In the presentation of a community collection and treatment alternative, the plan must state the estimated monthly sewer charge to each user. In addition, the estimated charge must be presented at the public hearing on the facilities plan.

COST GUIDELINES

Costs of residential disposal systems will, of course, vary depending on topography, the nature of the system, the size of system, and the area of the state. However, this Agency has asked the Illinois Department of Public Health to provide some cost figures based on rates charged by several central Illinois contractors. The following cost figures were suggested for the complete, installed price of conventional septic tank-tile field systems, on level ground:

750 gallon septic tank with 250 lineal feet of distribution field – $650 installed

1000 gallon septic tank with 300 lineal feet of distribution field – $800 installed

1500 gallon septic tank with 300 lineal feet of distribution field – $1050 installed

Buried sand filter installations of all types, including septic tanks and tile fields, were estimated to cost between $2000–$3000, with $2500 as an average.

Understandably, estimated costs will vary from county to county across the State. However, these figures will be used by this Agency as a basis for judging appropriateness of actual estimated costs for no action alternatives in facilities plans.

FmHA PROGRAMS FOR SMALL COMMUNITY SEWAGE FACILITIES

Glenn E. Walden*

It is indeed a pleasure for me to attend this conference on behalf of the Farmers Home Administration (FmHA) of the U.S. Department of Agriculture. This morning I would like to share with you some information about the Farmers Home Administration, particularly as it relates to the Agency's program of financial assistance to rural communities for the development of waste disposal systems. My discussion will touch on the Agency's delivery system, a brief review of the program background, funding, basic eligibility requirements, and some of our observations in working with rural communities in the development of waste disposal systems.

The Farmers Home Administration and its predecessor agencies have been in existence for well over 40 years and have administered a continually growing program of financial assistance to farmers, rural residents, and rural communities. These programs are administered through a delivery system composed of a network of 1777 county offices located throughout the Country, 42 State Offices, and a National Office located in Washington,D.C. Within each State there are district offices. The district director is a field representative of the State Director's staff and is the organizational link between the county and State office. The focal point in this delivery system is the local county office which is managed by the County Supervisor and staff and serves one or more counties. The county office should be an individual's or organization's first contact with the Agency since all requests for assistance are processed through this office. The State Office, composed of the State Director and staff, provides assistance to the County Supervisor when needed in processing applications. It also reviews and approves loans and grants which exceed the County Supervisor's approval authority. The National Office, composed of the Administrator and staff, provides program planning and policy guidance, technical assistance, and reviews and concurs in certain projects for approval consideration. This delivery system has proven to be a most effective approach to working with rural residents and rural communities, primarily because it offers ready access to the Agency at the local level and lends itself to establishing an effective channel of communication between Agency personnel and prospective applicants.

Through this delivery system the Agency administers over 27 different loan and grant programs that include funds to assist farmers and ranchers acquire, develop, and operate farms and ranches; housing for rural residents and migrant laborers; rural business and industrial development; and essential community facilities. These programs are budgeted at over $6.4 billion for fiscal year 1977. However, as I mentioned earlier, today we will focus on our loan and grant program for assisting rural community organizations in the development of new and improved waste disposal systems.

Authority for FmHA to finance community waste disposal systems originated in 1965 with the passage of the so-called Poage-Aiken bill. Prior to this time and dating back to 1937 with the passage of the so-called Water Facilities Act, FmHA and its predecessor agencies had worked only with farmers and other rural residents in the financing of community water systems. The Poage-Aiken bill also authorized a program of development grants for water and waste disposal facilities. Presently the program of loans and grants for communities is authorized under the authority of Section 306(A) of the Consolidated Farm and Rural Development Act.

As of December 31, 1976, the Agency and its predecessor agencies have committed over $3.5 billion of loan funds and $676 million of grant funds to approximately 9187 communities for the development of community water and waste disposal systems.

The systems financed under this program have or will provide service to over 3.5 million rural families or over 13.6 million rural people. The program has expanded considerably since 1970 with over 79 percent of the funds being committed since then. This indicates two important points:

1. There is a recognized need for new and improved water and waste disposal facilities in rural America.
2. Funds are being made available to meet these needs; however, the demand is far exceeding the funds made available.

As is the case with most other Agencies, we are dependent on funds made available annually with which to administer the program. For the 1977 fiscal year that we are presently in, we have available $600 million in loan

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funds and about $265 million in grant funds. I might point out that amounts are for both community water and waste disposal systems. Historically, we have given priority to water systems. This is not the case now, however. Our experience indicates that roughly two-thirds of the funds are used for water projects.

When the loan and grant funds are received they are allocated to the States based on a formula which considers each State's proportion of the U.S. population in open country and towns of less than 10,000 population outside urban areas and each State's proportion of rural per capita income which is below the National rural per capita income. The rural population factor and the rural per capita income factor are weighted 2 to 1, respectively.

In addition to the formula amount, each State is given a base amount of $20,000. A national reserve is maintained which is administratively distributed to the States by the Farmers Home Administration Administrator when he determines the additional allocation is necessary and appropriate. Within the State allocation, the FmHA State Director determines which projects should be funded.

Eligibility for water and waste disposal loans and grants is based primarily on five factors:

1. The applicant must be a public body such as a town, county, district or authority; a nonprofit corporation; or an Indian tribe. Water and waste disposal funds may not be used to serve any city or town having a population in excess of 10,000 according to the latest decennial census of the United States. Priority is given the public bodies serving communities with a population of 5,500 or less having an inadequate water or waste disposal system.

2. The applicant must be unable to obtain the needed funds from other sources at reasonable rates and terms. FmHA cannot compete with commercial credit sources.

3. The applicant must have the necessary legal authority to borrow funds and repay a loan, to pledge security for a loan, and to construct, operate, and maintain the facilities or services.

4. The applicant must propose a project that is economically feasible and one that represents a cost-effective approach to provide the needed service.

5. In the case of a grant, it cannot exceed 50 percent of the eligible project development cost. Grants are considered only on those projects serving the most financially needy communities where needed to help achieve a reasonable user cost. Ordinarily, grants are considered only when the debt service portion of the average user cost exceeds one percent of the median income for the community.

Funds may be used to build or improve facilities for waste collection and treatment including collection lines, treatment plants, outfalls, disposal fields, and stabilization ponds. Our authorities are quite broad in that essentially any cost necessary to establish a community water or waste disposal system is eligible. Our eligibility requirements are also broad and very few rural communities are ineligible, providing they do not have adequate water or waste disposal facilities and are unable to meet their credit needs through other credit sources at reasonable rates and terms.

As I mentioned earlier, all requests for Farmers Home Administration assistance should be made through one of our county offices. The County Supervisor will provide guidance to the applicant in assembling the necessary preliminary information and documentation as to the eligibility and feasibility of the proposal. This information consists of such items as preliminary cost estimates, feasibility studies, organizational documents, information on availability of other credit, options or required property rights, copies of consultant contracts, and financial statements. Funds are committed to the project based on a favorable review of this information. Once a tentative commitment of funds has been made, the applicant and its consultants normally proceed with final design, bidding, contracting, and actual construction of the facility.

At this point I would like to discuss with you in more detail some of our experiences in working with rural communities in assisting them to develop adequate waste disposal facilities. First, I think we should briefly discuss our requirements relative to the planning, designing, construction, and operation of these facilities. Basically, these are:

1. The facility must be designed, installed, and operated so as to meet the requirements of the State Health Department or State Regulatory Agency, as well as to meet the requirements of other financing institutions, and Federal, State, or local regulatory agencies.
2. Systems must have sufficient capacity to provide for reasonable growth.

Within this framework, we view our function primarily as that of a lending institution rather than a regulatory agency. However, in this area there is a great deal of latitude and room for judgment as to what constitutes adequate facility and what is cost-effective. In reviewing a proposal for funding, we must be mindful of the real needs of the community, the resources available in the community, and the potential of the community to properly operate and maintain the facility over the long-run. We can see no productive purpose in stifling rural community development which is the basic thrust of the Agency's program by financing facilities that are obviously beyond the means of rural communities to support or which are obviously not cost-effective or in harmony with the needs and desires of rural communities to provide the necessary infrastructure for its residents to have a better place to live and work.

Our experience has shown that due to a number of factors, many rural communities have and are continuing to install facilities that are very questionable from the standpoint of being truly cost-effective. Also, many rural communities have not been able to install any kind of system for reasons beyond their control. However, in viewing this whole spectrum, several issues stand out as being in need of consideration. These are:

1. The cost of developing waste disposal systems continues to increase due to inflation and other factors. For example, recent cost estimates for a waste disposal facility have run as high as $10,000 per connection which is far beyond the realm of possibility for many small communities.

2. Rural communities cannot be considered on the same basis as their urban or suburban counterparts due to differences in such things as population density, tax base, and income. However, their pollution problems are just as severe.

3. Rural communities many times do not have the "know how" or resources to properly operate and maintain large complex facilities that are being used in many cases at much less than their rated capacity. Many times costs such as utilities, attracting and retaining qualified operator personnel, when they are available, and treatment costs for regional type facilities, represent an unreasonable demand on users of the facility and the resources of the community as a whole. For example, we reviewed a proposal for funding of a waste disposal facility that would serve portions of three townships. The wastewater was to be treated by a regional-type plant. The treatment charge alone would amount to over $140 per year for residential size connections on the facility. When the operation and maintenance cost for the remainder of the system was added to this the total annual cost per connection before giving any consideration to reserve or debt retirement was over $177 per year.

4. There is a need for more funding to be made available in rural areas for development of waste disposal facilities. Several Federal agencies such as EPA, FmHa, HUD, EDA, as well as other private and institutional lenders are providing funds. However, several of the programs are urban oriented and a small percentage of the total funds available are actually being channeled into rural communities.

In considering available options to try to deal with the issues I have just mentioned, FmHA believes that there are several viable approaches. We recognize, of course, that there are not any patent answers and that each community must be looked at individually. However, based on our experience in working with rural communities over the years, we offer the following as some possibilities. Most of these are interrelated.

1. In considering the development of a waste disposal system, a realistic design should be permitted without being locked into a given type of collection or treatment system as specified by a regulatory agency so long as the facility is designed in accordance with sound engineering practices and represents proven technology. For example, we have found that in many cases a waste stabilization pond with disposal of the effluent by land treatment would provide the degree of treatment needed much more economically than through the use of a mechanical plant. Another example consists of a case where a cost savings of approximately 30 percent was realized by using a vacuum-type collection system rather than a conventional gravity flow. In addition, we have financed several pressure sewers with interceptor tanks that are providing satisfactory results. We are not inferring that in many cases the use of mechanical plants and conventional gravity collectors will not result in a cost-effective design simply by proper sizing of the facility.

I would like to emphasize again here that the real needs of the community and its available resources be considered.

2. Additional consideration should be given to the training of operator personnel. Most States have implemented an effective training program, however, there is still a large gap between the demand and the availability of trained personnel.

3. The use of shared services should be used to the extent practical. In many cases this offers a viable option to small communities to enable them to acquire needed services of the desired caliber. Along this same line the consolidation or merger of smaller facilities should be considered when economies of scale can be achieved. However, our experience indicates that in many cases the regional concept has not been effective in providing any reduction in the cost of these services. In many cases, we have found that the cost of connecting to and using a regional system has been exorbitant for many small communities.

I realize that this discussion has only brushed the surface about many of the complex issues involved in development of waste disposal facilities for small communities and about our financial assistance program. However, there are no easy answers and consensus is difficult to achieve many times as to the correct approach.

I would again like to express my appreciation for allowing us this time to talk with you about the role of the Farmers Home Administration in rural community waste disposal system development.

FOR ALTERNATIVE WASTEWATER FACILITY FOR A SMALL UNSEWERED COMMUNITY

*Richard J. Otis**

Few viable alternatives for small communities and subdivisions have ever been tried nor have there been incentives to do so. However, with the emphasis for cleaning up our nation's waterways moving from large municipalities to small communities, it is being realized that conventional solutions are too costly and may not be practical. This has caused the search for alternatives by several communities including Westboro, Wisconsin (1, 2), Glide, Oregon (3), and Fountain Run, Kentucky (4). The Glide, Oregon and Fountain Run, Kentucky plans are discussed elsewhere at this conference (5, 6).

WESTBORO, WISCONSIN

Westboro, Wisconsin is typical of hundreds of small rural communities in the Midwest that are in need of improved wastewater treatment and disposal facilities but are unable to afford conventional sewerage. Westboro was established as a permanent northern Wisconsin community in the late 1850's as a result of the lumber industry (Figures 1 & 2). By 1900 the population had grown to about 900, but with the decline of the lumber industry the population also declined. The present population is approximately 200 persons. A small machine tool company and a sawmill employing a total of 5 to 10 people remain in town.

The community of Westboro has no municipal wastewater collection or treatment facility. There are 94 buildings located in the community, of which 69 are occupied, including a school, four churches and several commercial establishments. All are served by private wastewater disposal systems. A 1971 survey by the Wisconsin Department of Natural Resources (DNR) showed that 80% of the septic tank systems were discharging wastes above ground. Many of the systems were found to be interconnected by common drains discharging directly into Silver Creek which flows through town. This situation was declared a nuisance and a menace to health and comfort, as well as the public rights in the Upper Chippewa River Basin. Consequently, DNR issued an order to Westboro to stop all private homes from discharging wastes into Silver Creek, either by upgrading all failing septic tank systems or constructing public wastewater facilities.

Proposed Central Sewerage

The soils and lot sizes prevent the replacement of most of the failing septic tank systems on an individual basis (Figure 3) so a public facility was determined to be necessary. The community formed a sanitary district, "Sanitary District No. 1 of the Town of Westboro" (Figure 2), and in 1967 contracted with an engineering firm to complete a facilities plan to abate the water pollution problem. The first investigated two alternatives, (1) gravity collection to an extended aeration package treatment plant and (2) gravity collection to a two cell lagoon. Both plans served only 60 of the 69 occupied buildings. Homes to the north of town near Appaloosa Lane and those east of Silver Creek in Queenstown were not included. (See Figures 4 & 5) Construction costs updated in 1976 were $136,295 for the collection system required for both alternatives, $170,065 for the package plant with a required 30-day effluent holding pond and $185,528 for the stabilization lagoon (1). Total construction costs of these facilities, therefore, are estimated to be $306,360 for Alternate 1 and $321,823 for Alternate 2, excluding engineering and contingencies (1).

The Westboro Sanitary District applied for Federal EPA grants in aid of construction, but their priority for receiving funding was very low. As of February, 1976, Westboro was 318 on the list of 420 to receive 75 percent of eligible costs of construction of the treatment plant and interceptors and 398 to receive similar funding for the sewers. This virtually ruled out the possibility of obtaining a community facility for several years.

Alternative Non-Central Facilities Evaluated

Having a sincere interest in abating their problem, the residents of the Westboro Sanitary District agreed to cooperate with the Small Scale Waste Management Project at the University of Wisconsin to develop an alternate plan which might be a more cost-effective facility. The objectives of the project were to evaluate the use of several small treatment and disposal systems placed in strategic locations within the community to serve indi-

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Division of Economic and Environmental Development
University of Wisconsin-Extension

Figure 1. Geographic Location of Westboro, Wisconsin

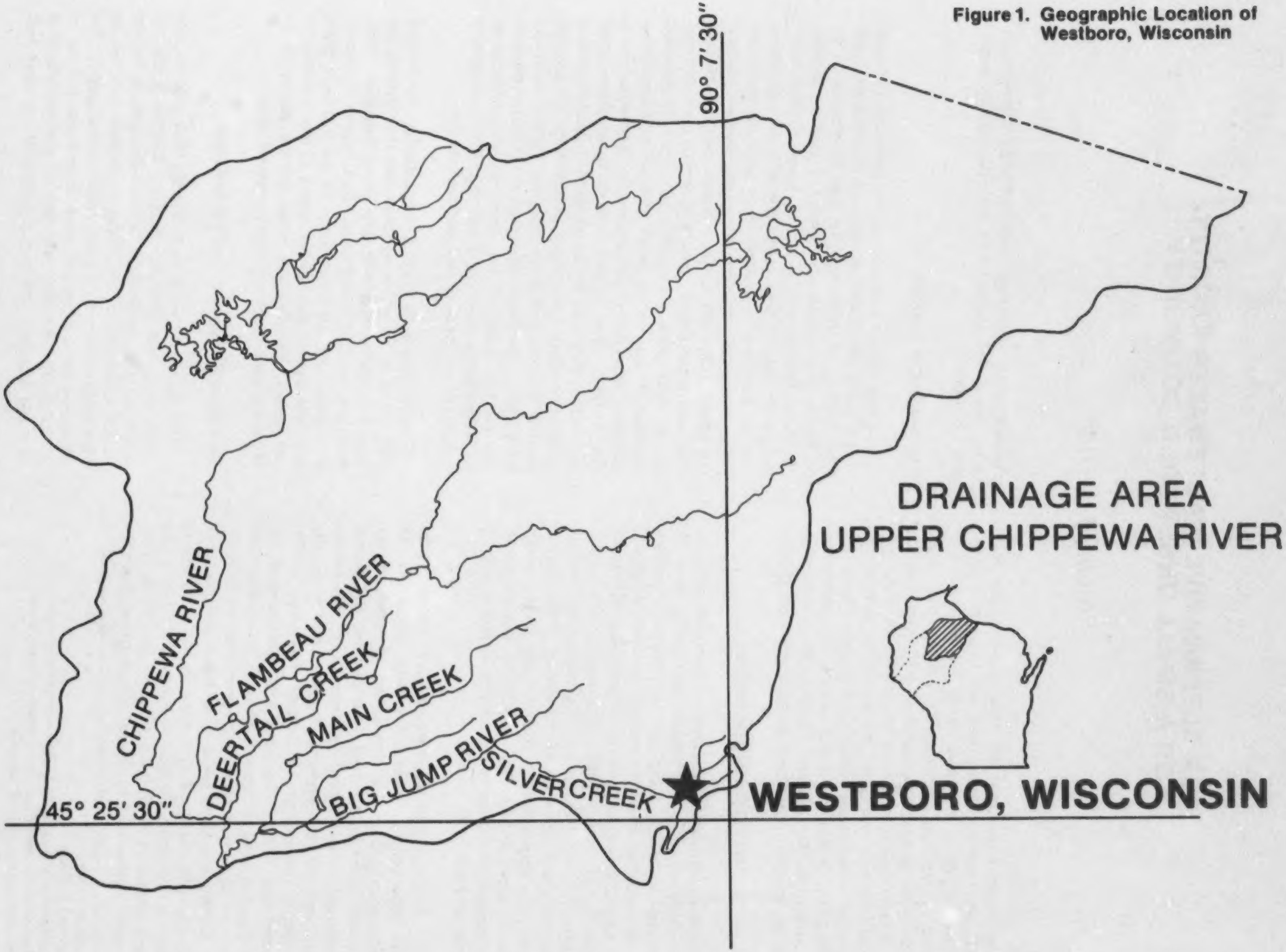

90° 7' 30"
45° 25' 30"
DRAINAGE AREA
UPPER CHIPPEWA RIVER
WESTBORO, WISCONSIN
CHIPPEWA RIVER
FLAMBEAU RIVER
DEERTAIL CREEK
MAIN CREEK
BIG JUMP RIVER
SILVER CREEK

Figure 2. Sanitary District #1 of the Town of Westboro

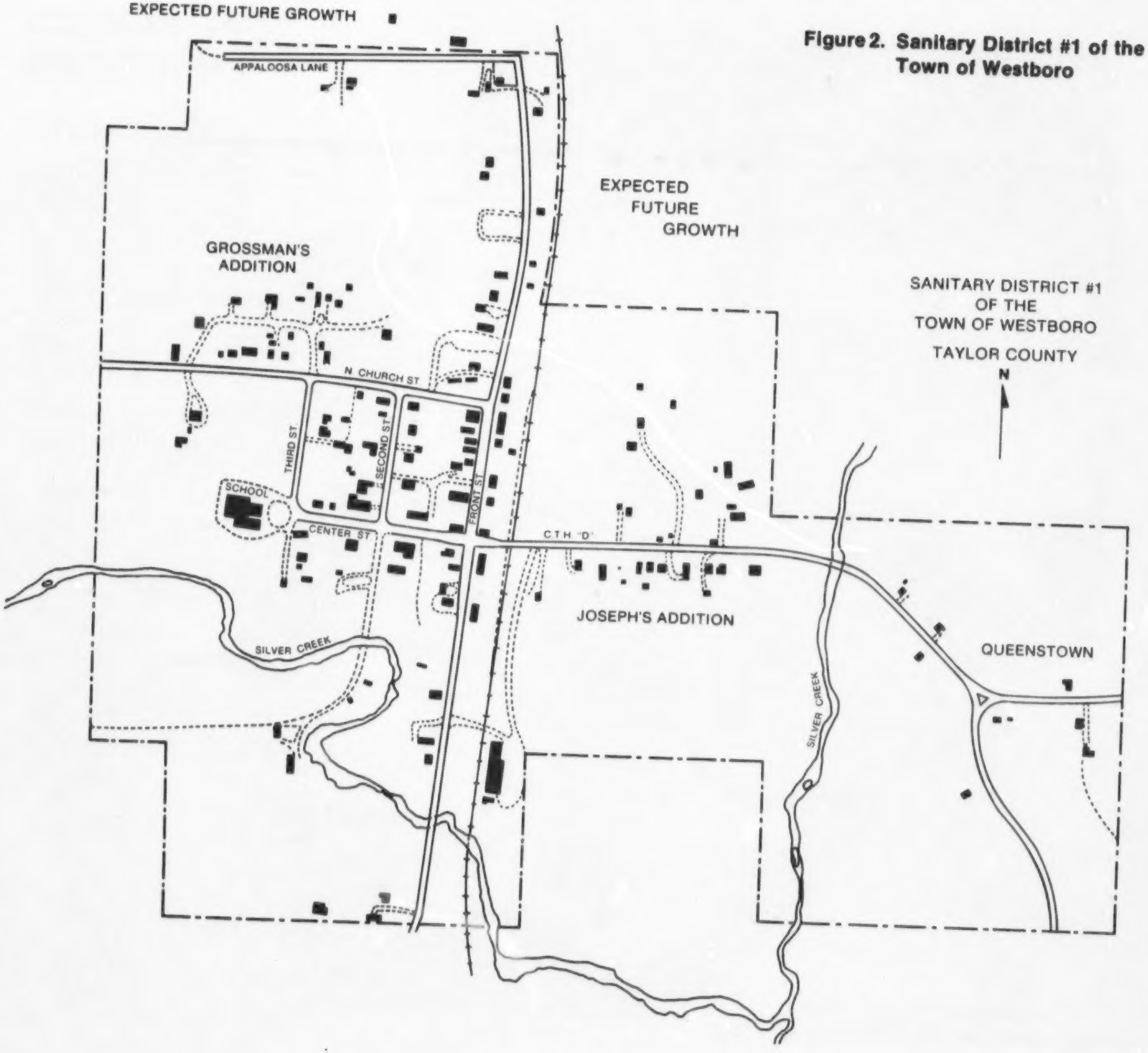

EXPECTED FUTURE GROWTH
APPALOOSA LANE
GROSSMAN'S ADDITION
EXPECTED FUTURE GROWTH
SANITARY DISTRICT #1
OF THE
TOWN OF WESTBORO
TAYLOR COUNTY
N
N CHURCH ST
THIRD ST
SECOND ST
FRONT ST
SCHOOL
CENTER ST
C.T.H. "D"
JOSEPH'S ADDITION
QUEENSTOWN
SILVER CREEK
SILVER CREEK

Figure 3. Soil Suitability for Conventional Septic Tank Systems

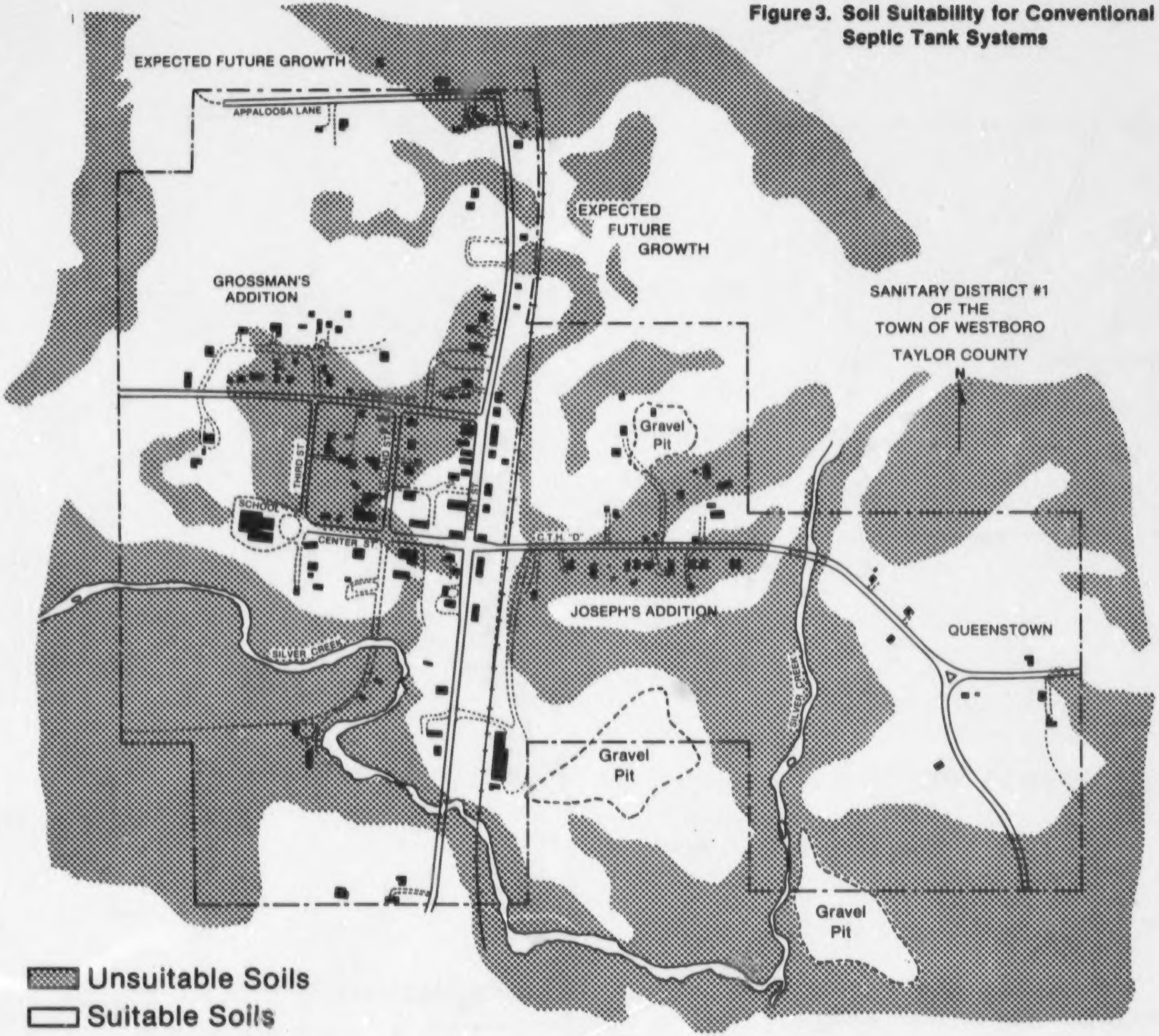
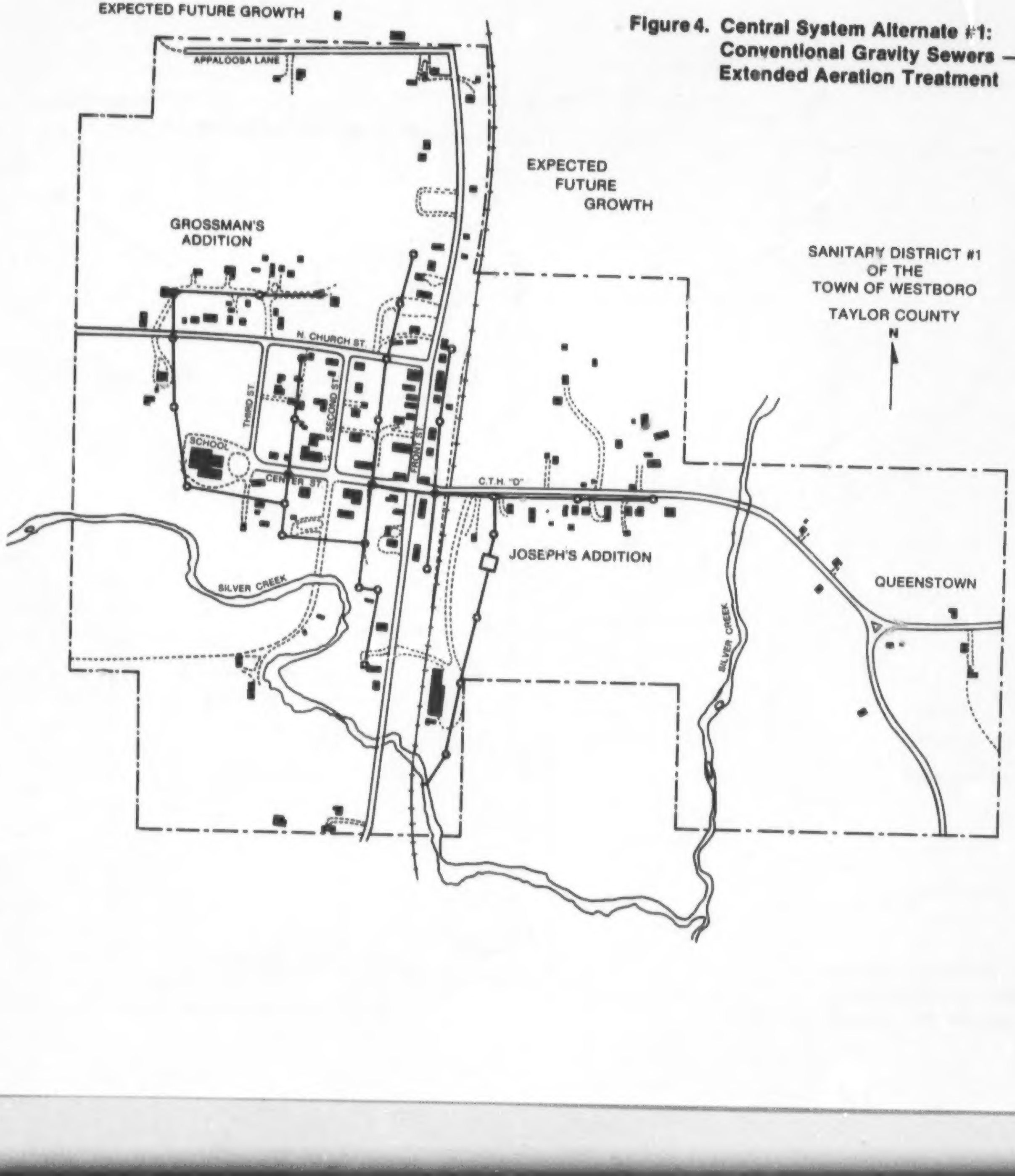

EXPECTED FUTURE GROWTH
APPALOOSA LANE
EXPECTED FUTURE GROWTH
GROSSMAN'S ADDITION
SANITARY DISTRICT #1 OF THE TOWN OF WESTBORO TAYLOR COUNTY
N
Gravel Pit
THIRD ST
SECOND ST
FRONT ST
SCHOOL
CENTER ST
C.T.H. "D"
JOSEPH'S ADDITION
QUEENSTOWN
SILVER CREEK
SILVER CREEK
Gravel Pit
Gravel Pit
▨ Unsuitable Soils
☐ Suitable Soils

Figure 4. Central System Alternate #1: Conventional Gravity Sewers — Extended Aeration Treatment


EXPECTED FUTURE GROWTH
APPALOOSA LANE
EXPECTED FUTURE GROWTH
GROSSMAN'S ADDITION
SANITARY DISTRICT #1 OF THE TOWN OF WESTBORO TAYLOR COUNTY
N
N. CHURCH ST.
THIRD ST.
SECOND ST.
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SILVER CREEK
QUEENSTOWN
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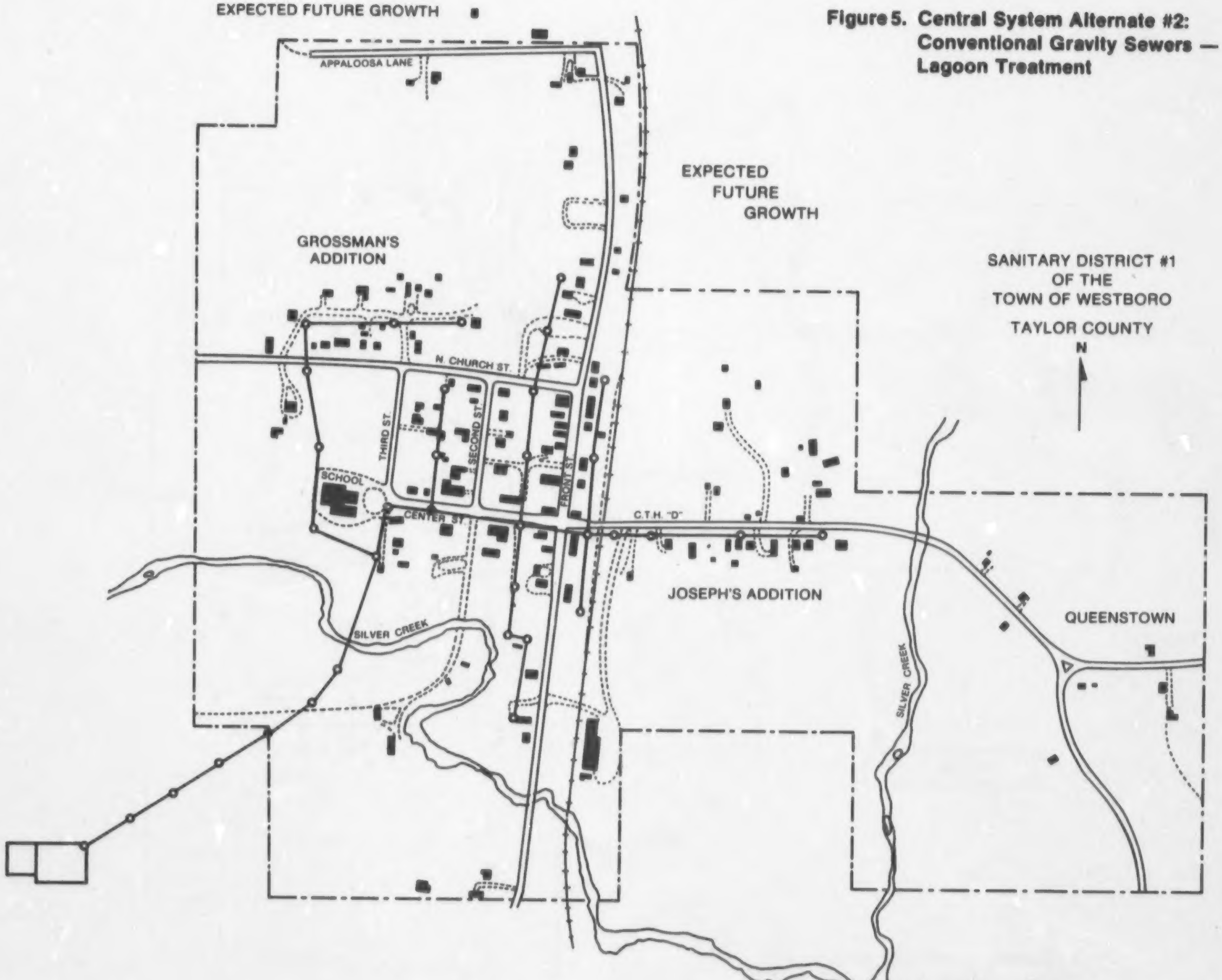
Figure 5. Central System Alternate #2: Conventional Gravity Sewers — Lagoon Treatment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SANITARY DISTRICT #1
OF THE
TOWN OF WESTBORO
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GROSSMAN'S ADDITION
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SILVER CREEK
QUEENSTOWN

vidual homes or clusters of homes, but under central management, to compare total costs of alternate plans to the proposed conventional facility, and to determine the best method of management of such alternate facilities.

Since the collection sewers represented approximately half of the total construction costs in the conventional plans, an effort was first made to reduce the size of the collection system. The community was divided into natural groupings of buildings for the consideration of various alternatives. Five groupings were made: (1) Front Street area, extending from Silver Creek north to the cemetary and from Second Street to the railroad tracks, (2) Grossman's Addition, including the area west of Second Street and the school, (3) Joseph's Addition, (4) Queenstown and (5) Appaloosa Lane, including the scattered houses north of the Front Street area (Figure 6). Each area was considered separately and in combination with adjacent areas to develop the most cost-effective system.

Collection systems were considered to be the best alternatives for the Front Street area which includes the business district. This area is primarily divided into small 150' x 50' lots. Most of the lots are developed leaving little area to construct new individual septic tank systems. Joseph's Addition is a low lying area with poorly drained soils. Individual mound systems could be installed but a common system would be more cost-effective. A similar condition occurs in Grossman's Addition area where individual systems could be installed, but because of the density of homes, a common system offers the greatest advantage.

Several alternatives were considered for these areas. Because of the limited disposal sites available, it was appropriate to combine the Front Street and Joseph's Addition areas, with disposal to an extensive sand bench along Silver Creek east of town. Both pressure and small diameter gravity sewers (7) collecting septic tank effluents were evaluated for these combined areas. In Grossman's Addition, four alternatives were evaluated. Because of topography, collection by small diameter gravity sewers to a point southwest of the school is well suited for this area. Disposal alternatives considered were soil absorption, sand filtration with chlorination before discharge to Silver Creek and pumping to the Front Street and Joseph's Addition gravity system. The fourth alternative was a pressure collection system, also combined with the Front Street and Joseph's Addition pressure system.

The remaining Appaloosa Lane and Queenstown areas are too sparcely developed to warrant collection systems. At present, individual systems seem to be the best alternative. Farm land with soils suitable for either a conventional or mound disposal system exist.

In summary, the non-central alternatives evaluated were (1):

Alternate 1

Part A: Grossman's Addition — Small diameter gravity sewers discharging to a soil absorption field west of the school (design load of 10,000 gpd).

Part B: Front Street and Joseph's Addition — Small diameter gravity sewers discharging to a soil absorption field northeast of Joseph's Addition (design load of 20,000 gpd).

Alternate 2

Part A: Grossman's Addition — Small diameter gravity sewers discharging to a soil absorption field west of school (design load of 10,000 gpd).

Part B: Front Street and Joseph's Addition — Pressure sewer discharging to a soil absorption field northeast of Joseph's Addition (design load of 20,000 gpd).

Alternate 3 (Figure 7)

Part A: Grossman's Addition — Small diameter gravity sewers discharging to intermittent sand filters west of the school with chlorine disinfection before disposal into Silver Creek downstream from the community (design load of 10,000 gpd).

Part B: Front Street and Joseph's Addition — Small diameter gravity sewers discharging to a soil absorption field northeast of Joseph's Addition (design load of 20,000 gpd).

Alternate 4 (Figure 8)

Part A: Grossman's Addition — Small diameter gravity sewers discharging onto intermittent sand filters west of the school with chlorine disinfection before disposal into Silver Creek downstream from the community (design load 10,000 gpd).

Part B: Front Street and Joseph's Addition — Pressure sewers discharging to a soil absorption field northeast of Joseph's Addition (design load of 20,000 gpd).

Alternate 5 (Figure 9)

Small diameter gravity sewers serving all areas to a soil absorption field northeast of Joseph's Addition (design load of 30,000 gpd).

Alternate 6 (Figure 10)

Pressure sewers serving all areas discharging to a soil absorption field northeast of Joseph's Addition (design load of 30,000 gpd).

Figure 6. Grouping of Homes Made for Evaluation of Alternatives

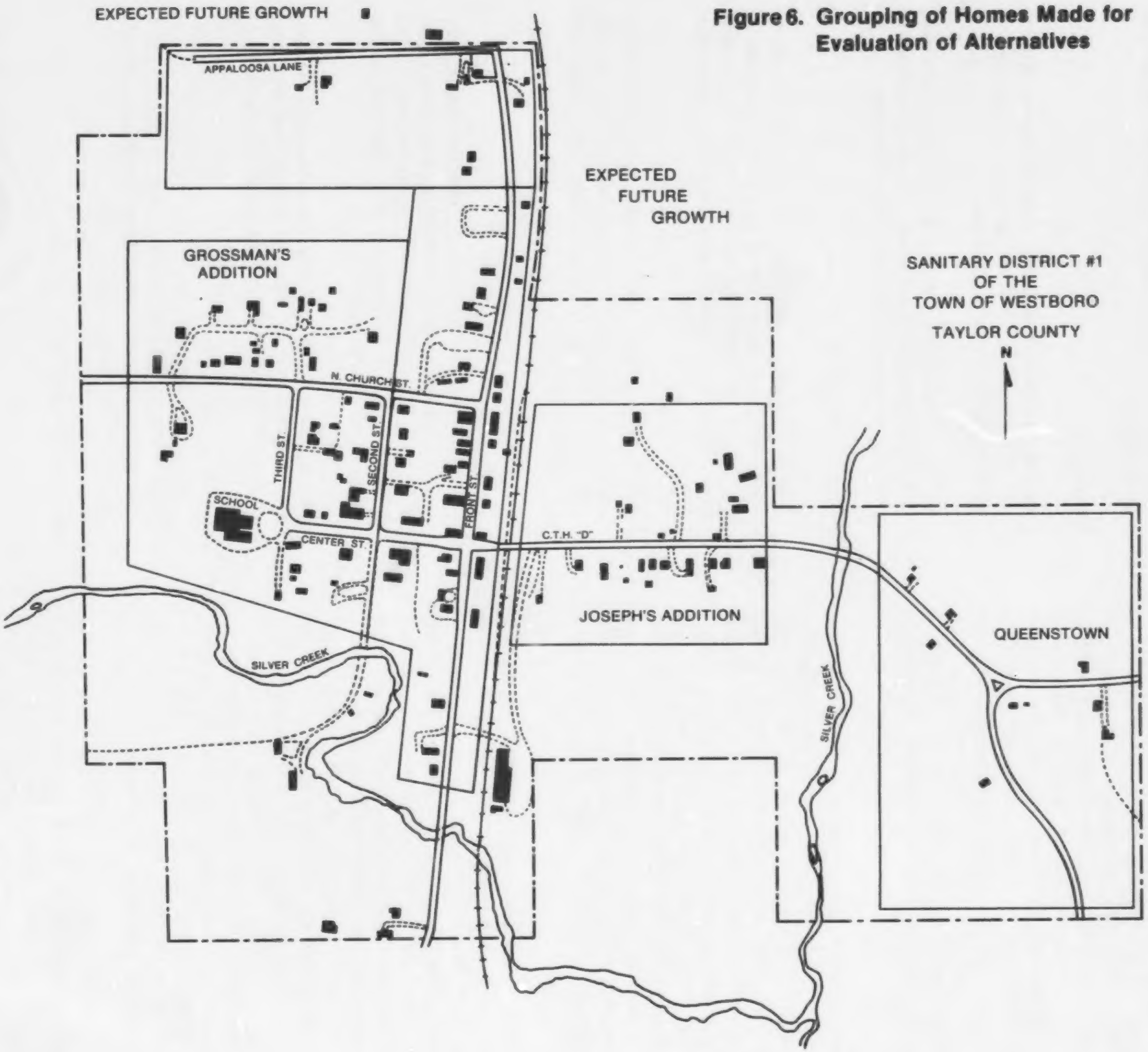
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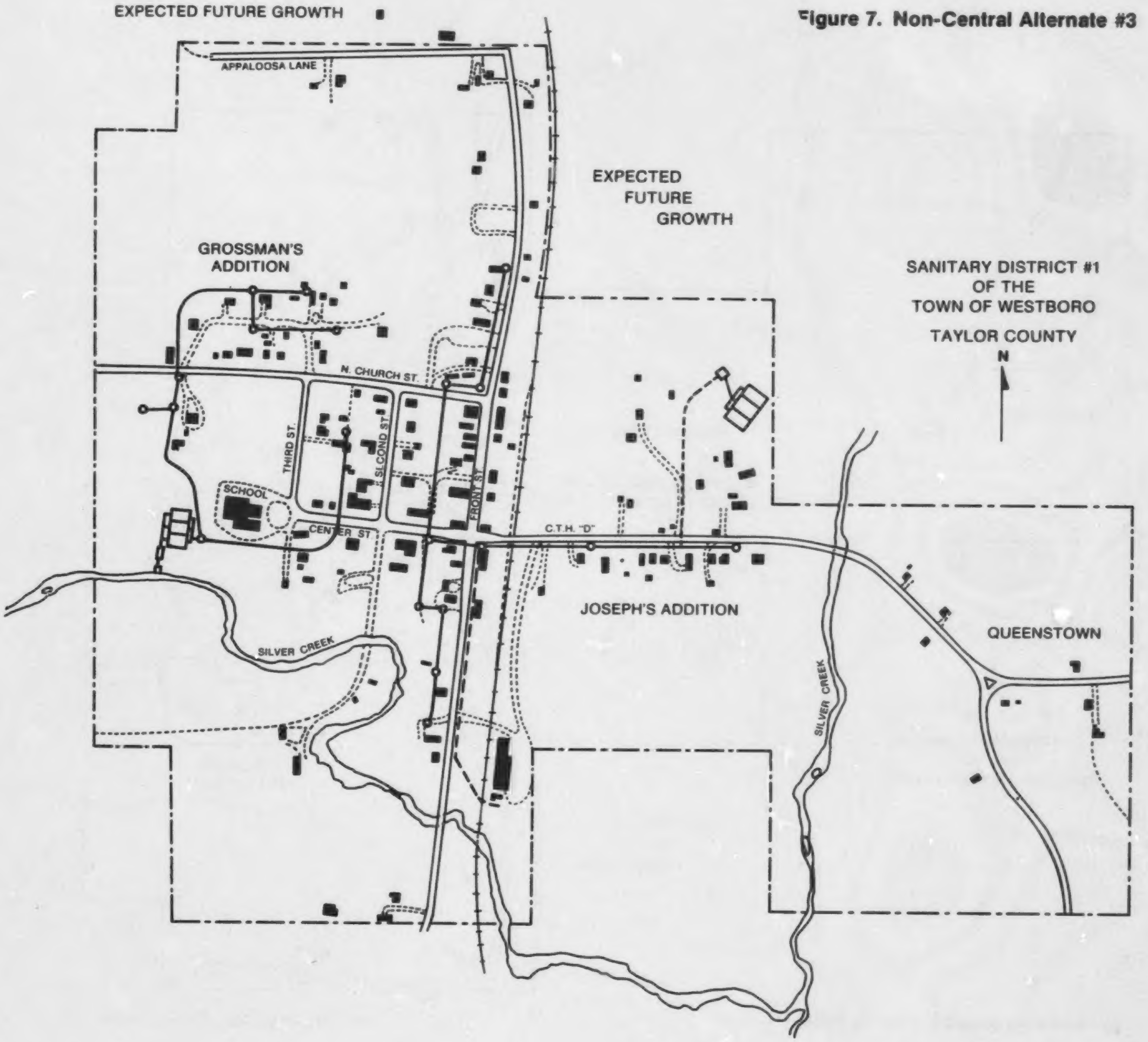
Figure 7. Non-Central Alternate #3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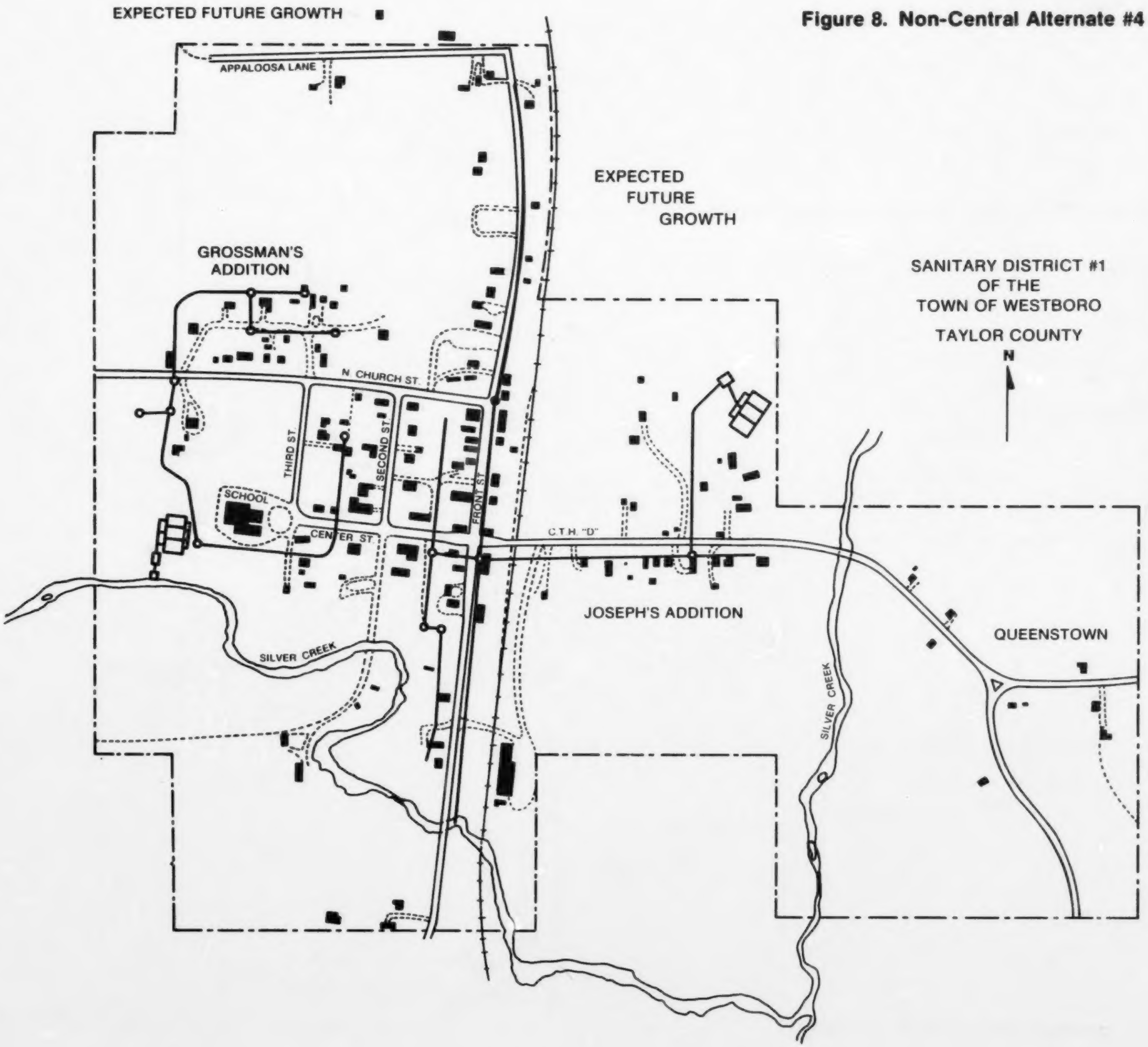
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Figure 8. Non-Central Alternate #4

Figure 9. Non-Central Alternate #5

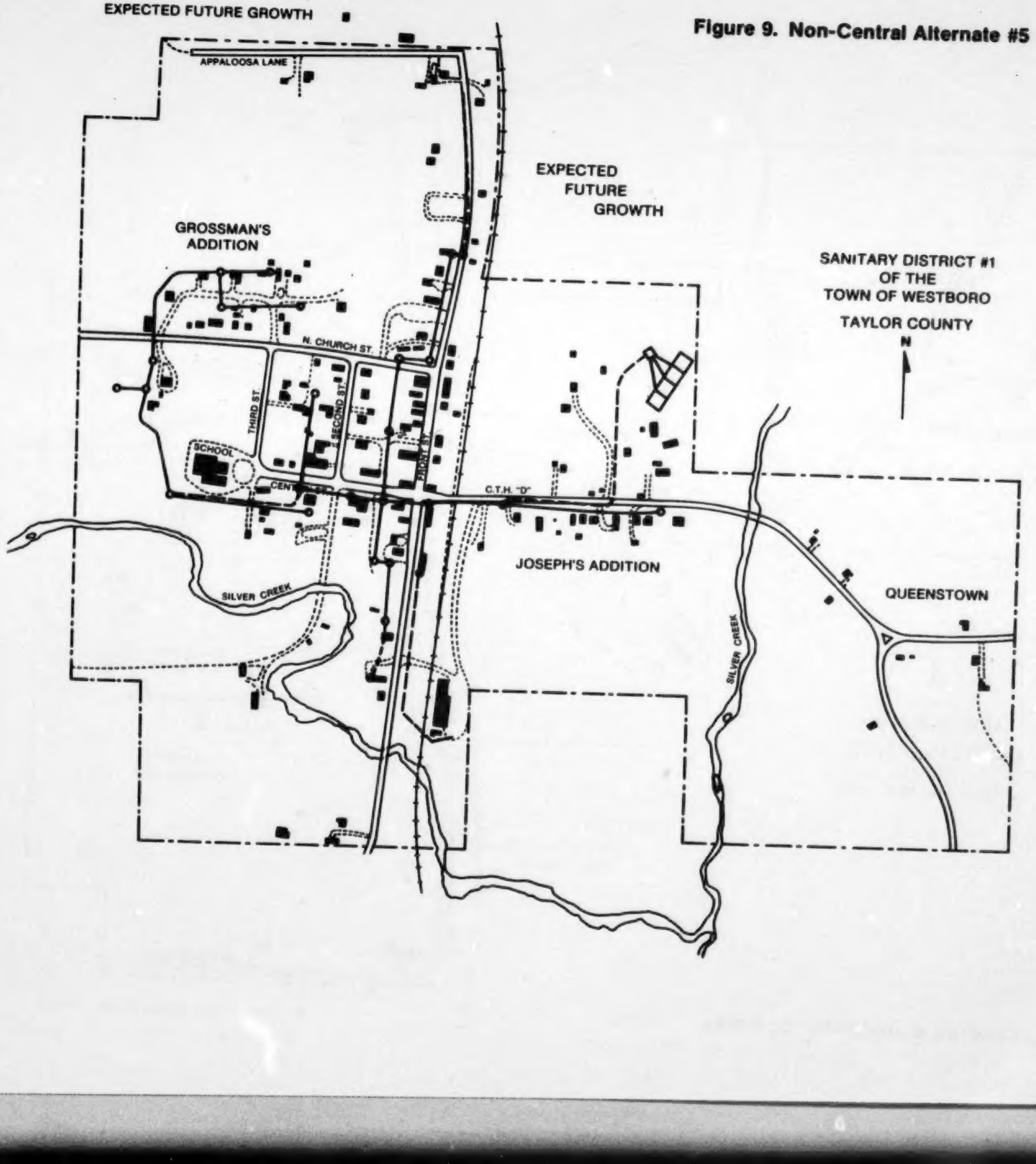
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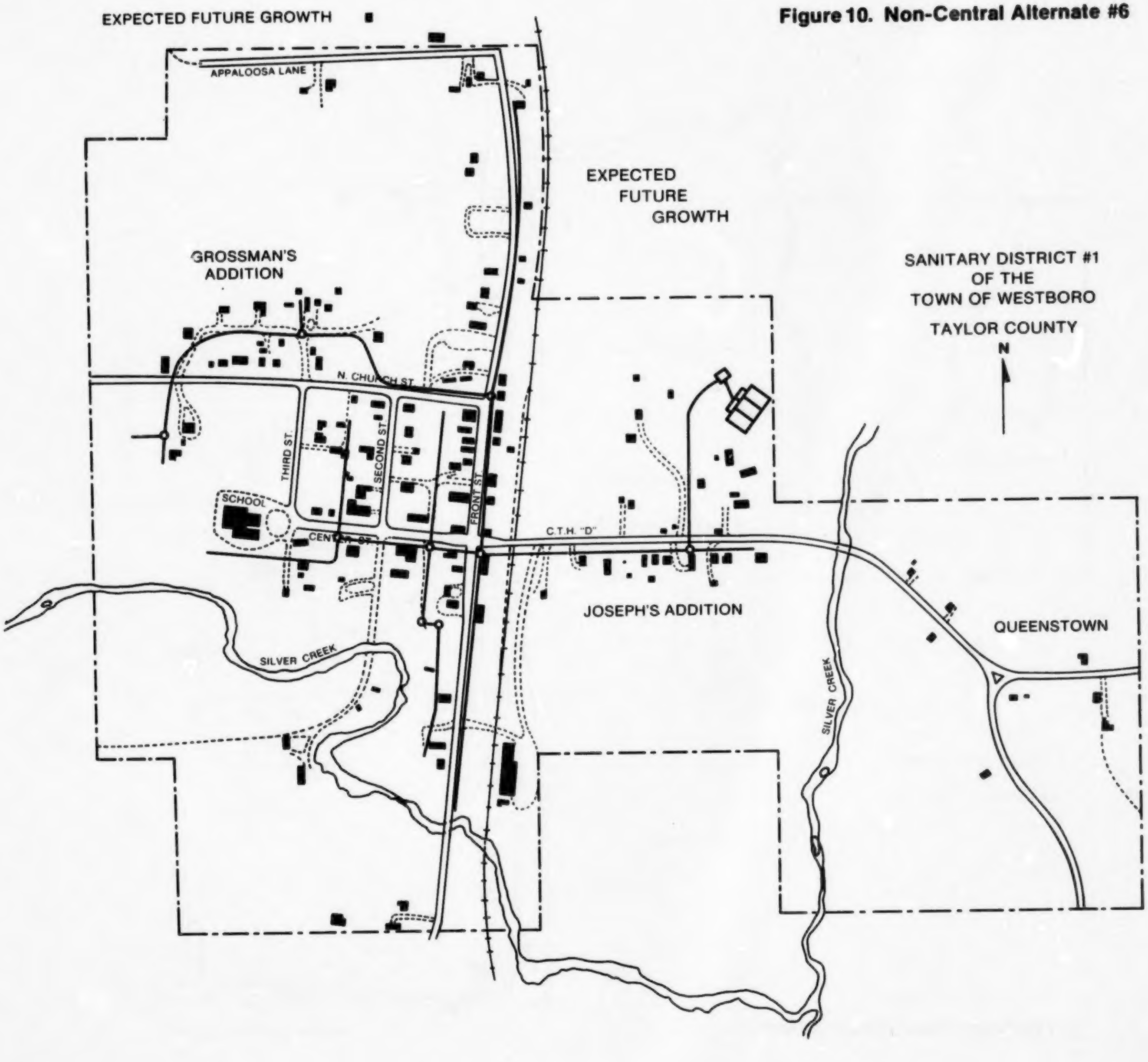
Figure 10. Non-Central Alternate #6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Facility Selection

Final selection of one alternative over several others depended on three criteria: environmental impact, total cost, and system reliability. The first two are obvious, since it is the goal of the engineer to design a facility which will protect the environment for the least cost. Judgments must be made as to whether additional environmental protection warrants added facility costs but much of this can be decided objectively. System reliability is less objective, however, and is influenced by the engineer's past experience. It is often more a confidence factor which will eliminate some alternatives from consideration because they are not felt to be viable. This factor is what usually eliminates septic tank systems from consideration. Each of these must be weighed in the final selection.

The "Non-Central" Alternate #5 was selected as the best facility after weighing each criterion, though some assumptions made in the analysis must be proven through experience. This facility is a system of small diameter gravity sewers with final effluent disposal in a single soil absorption field (Figure 9). Pretreatment would be provided by individual septic tanks at each home. The effluent is conveyed to a conventional soil absorption field which is divided into 3 beds providing 1.5 times the estimated area necessary for absorption. Two beds would be in use at all times. The third would be alternated into use on a regular basis. This arrangement permits a bed to rejuvenate by "resting" and provides a stand-by unit. Homes outside the collection system would be served by individual septic tank systems.

This facility appears to be the least costly and more environmentally sound than the other alternatives evaluated. The reliability of this type of facility has not been established, however, but its selection is warranted because it is designed from extensive experience with smaller systems. In addition, its cost and environmental impact are a significant improvement over the conventional central facilities.

Cost comparisions between all alternatives were made using present worth analysis. Present worth is equal to the initial cost plus the amount of money which must be invested at the present time to cover the costs of operation and maintenance over the life of the system. A lifetime of 20 years with an annual interest rate of 7 percent was used in these computations. A summary of the estimated present worth of each alternate is presented in Table I.

To make a fair comparison of costs, the conventional central facility alternates were redesigned to conform with present regulations and site conditions. Private individual system construction estimates were also included for those homes not served by the conventional alternates. While the cost of replacing these septic tank systems would not be borne by the District in the case of the conventional system their inclusion provides a fairer comparison between the "Central" and "Non-Central" alternates. Hookup costs are also included for Alternates 1 and 2. They are estimated to be $450 per service connection. Hookup costs for the "Non-Central" alternates are included in the construction costs.

"Non-Central" Alternate #5 is estimated to be the least costly of all the alternatives evaluated. The present worth of Alternate #5 is $266,416 or approximately $3861 per household, as compared to $349,386 or $5063 per household and $384,849 or $5578 per household for the "Central" Alternates #1 and #2 respectively. Thus, the non-central system results in a 25 to 30 percent savings per connection over the conventional facilities.

The environmental impact of "Non-Central" Alternate #5 should be minimal. Only nitrogen in he form of nitrate is expected to leach through the soil to the groundwater in amounts that may be significant. With the field's location near Silver Creek much of the nitrate will probably flow into Silver Creek increasing its nitrogen content. Phosphorus, however, will have been removed through adsorption and precipitation reactions in the soil. Pathogenic bacteria and viruses should also be removed. This method of disposal is superior to direct discharge of treated effluent into Silver Creek because such effluents contain phosphorus and pathogenic organisms and viruses, as well as nitrogen.

Institutional Arrangements

To properly manage its non-central system, the Westboro Town Sanitary District must regulate all individual and jointly used onsite disposal systems operating within its boundaries. While no Town Sanitary District has attempted this in Wisconsin, it is within their power to do so (1, 2). Briefly, advantages would arise because the District would be able to better perform the following functions:

1. Design and construct sanitary facilities for existing and future structures.
2. Identify and obtain rights to land with suitable soils for disposal areas setting aside sufficient areas for future growth.
3. Operate and maintain all individual and joint systems within the District, including pumping of all septic tanks.
4. Monitor groundwater and surface water quality to detect failing systems.
5. Repair or reconstruct any failing systems.
6. Establish a fair assessment and rate structure for subscribers to pay for cost of services.
7. Apply grants in aid of construction for portions of the sanitary facilities that the District will own.

Access to Private Property: Many of the facility components of the recommended non-central facility, such as septic tanks and effluent pumps will be located on private property. Since regular maintenance of these components

Table I. Summary of Present Worth Costs of Alternate Facilities

"CENTRAL" SYSTEM ALTERNATE #1

Extended Aeration Treatment Plant

Collection	$136,295.00	
Treatment	170,065.17	
Hookup	31,050.00	
Individual Systems	11,976.23	
		$349,386.40

"CENTRAL" SYSTEM ALTERNATE #2

Raw Sewage Stabilization Pond

Collection	$136,295.00	
Treatment	185,528.00	
Hookup	31,050.00	
Individual Systems	11,976.23	
		$384,849.23

"NON-CENTRAL" SYSTEM ALTERNATE #1

Part A: Grossman's Add. – S.D. Gravity Sewers to Soil Absorption
Part B: Front St. & Joseph's Add. – S.D. Gravity Sewers to Soil Absorption

Part A	$124,454.64	
Part B	145,229.00	
Individual Systems	11,976.23	
		$281,659.87

"NON-CENTRAL" SYSTEM ALTERNATE #2

Part A: Grossman's Add. – S.D. Gravity Sewers to Soil Absorption
Part B: Front St. & Joseph's Add. – Press. Sewers to Soil Absorption

Part A	$124,454.64	
Part B	185,308.00	
Individual Systems	11,976.23	
		$321,738.87

"NON-CENTRAL" SYSTEM ALTERNATE #3

Part A: Grossman's Add. – S.D. Gravity Sewers to Sand Filters
Part B: Front St. & Joseph's Add. – S.D. Gravity Sewers to Soil Absorption

Part A	$148,038.00	
Part B	145,229.00	
Individual Systems	11,976.23	
		$305,243.23

"NON-CENTRAL" SYSTEM ALTERNATE #4

Part A: Grossman's Add. – S.D. Gravity Sewers to Sand Filters
Part B: Front St. & Joseph's Add. – Press. Sewers to Soil Absorption

Part A	$148,038.00	
Part B	185,308.00	
Individual Systems	11,976.23	
		$345,322.23

"NON-CENTRAL" SYSTEM ALTERNATE #5

Total Gravity Sewers to Soil Absorption

Joint System	$254,440.00	
Individual Systems	11,976.23	
		$266,416.23

"NON-CENTRAL" SYSTEM ALTERNATE #6

Total Pressure Sewers to Soil Absorption

Joint System	$294,154.00	
Individual Systems	11,976.12	
		$306,130.23

is necessary for proper functioning of the facility, permanent legal access to the properties must be obtained for purposes of installation, operation, and maintenance. These easements are required prior to construction. In most cases, however, the exact location of the existing septic tank is unknown. Therefore, a general easement tied to the location of the septic tank rather than the property line is proposed (1). Easements must also be obtained for any collection sewers of joint systems which cross private property.

It is hoped that the necessary easements can be acquired voluntarily from the property owners. Since all property owners within the district will be assessed for the cost of the facility, whether they use the facility or not, the owners might be encouraged to grant the required easements. Another factor which might serve to encourage the property owners to grant easements is the risk of prosecution by the county or state against the continuing use of their failing septic tank system. If the property owner fails to grant the easement voluntarily, however, the District could condemn such easements through eminent domain proceedings. This alternative, of course, is undesirable. The success of the non-central system depends on a strong "community effort."

Subscriber's Responsibilities: The District will be responsible for the operation and maintenance of all components of the facility located on private land commencing from the inlet of the septic tank. The property owner's only responsibility will be to provide and maintain the lateral drain from his home or establishment to the septic tank and any power costs associated with lifting his effluent into the collection sewer or absorption field, if necessary.

Financing of Proposed Plan

Since Westboro's priority for Federal EPA construction grants is very low, other sources of funding were sought for construction of the proposed facility. Commitments were obtained from the Wisconsin Department of Natural Resources and the USDA Farmer's Home Administration (FmHA) for grants totaling approximately 50 percent of the construction costs. The remainder of the construction funds would be provided by a FmHA 5 percent, 40 year loan.

Special easements and monthly charges will have to be determined by the commissioners of the Sanitary District. However, to estimate their grant contribution, FmHA assumed a monthly charge of $10 per residence ($8/month debt retirement, $2/month operation and maintenance), $15 per commercial establishment and $1240 for the school and a 0.004 sanitary levy which would be sufficient to retire the debt and cover costs for operation and maintenance. Special assessments of $200 per residence, $300 per commercial establishment, and $1500 to the school would be the remaining contribution made by the community.

Since those residents who recently constructed new septic tank systems would be reluctant to join the system, credit would be extended to them depending on the age and condition of their septic tank. In some cases the septic tank would be suitable for use by the community system, thereby saving the district the cost of a septic tank. This savings will be returned to the owner in an inverse proportion to the age of the tank.

New subscribers joining the system after construction of the facility should be expected to pay a larger assessment. A formula might be worked out whereby new residents would pay all costs of hooking to the collection sewer and their share of the absorption field. This is a decision which will have to be made by the district commissioners.

While the costs are within the financial capabilities of the community, the financial grants are not as large as hoped. Biases in funding guidelines prevent agencies from providing more despite the fact that Westboro made efforts to construct a more cost-effective facility. The DNR grant from funds provided by the State of Wisconsin is limited to 25 percent of construction costs of grant eligible items. Any portion of the system located on private property, whether or not permanent easements have been given, is not considered eligible. This is unfortunate, since it disallows the septic tanks which provide partial treatment necessary to permit the use of less costly sewers. The savings made by DNR due to the more cost-effective facility are not passed on to the community. Land purchase is also excluded, though the soil becomes the final treatment facility in this plan.

The Farmers Home Administration does not distinguish between items for eligibility but rather bases their grant contribution on what they feel is the community's ability to pay. For the portion to be paid by the community, a 5 percent, 40 year loan is offered. The amount of the grant portion is determined by assuming a monthly charge and special assessment per residence and a sanitary tax levy according to the wealth of the community. This income is used to retire the debt and pay for operation and maintenance over the 40 year loan period. By back calculating, the amount of the grant is determined but it cannot exceed 50 percent of the total construction costs.

Both of these policies do not provide much incentive for communities to construct more cost-effective facilities. The guidelines for the DNR grant program should be reevaluated to see whether or not vital portions of the system located on private property cannot be grant eligible if permanent easements are obtained. If not, the community would be inclined to construct as much of the system on public right of way as possible. This could increase the cost to DNR and the taxpayer, but reduce the cost of the resident.

The FmHA policy provides little more incentive to construct less costly systems. By back calculating from a basic monthly charge and special assessment, the cost to the community residents changes little, regardless of the cost of the facility. This policy must be made more flexible to credit communities willing to make an effort to reduce costs.

Monitoring Program

Performance reliability of the proposed facility remains to be proven. Public ownership and management of septic tanks located on each private lot served is rather new. The success of small diameter gravity sewers depends upon proper maintenance of the septic tanks. Further, the effects of a large soil absorption field on groundwater quality have not been established. These items will be monitored by SSWMP for the next three years, pending the availability of funding.

SUMMARY

The demand for less costly wastewater facilities for small communities or fringe areas is increasing. Regulatory officials and engineers are realizing that if the goals of the Federal Water Pollution Control Act are to be met, more practical facilities must be developed for small communities and subdivisions. Recent studies have shown that up to 25 to 50 percent savings can be realized in public wastewater facilities in small communities by using alternatives to conventional sewerage (1, 3, 4).

Non-central facilities may also provide an alternative for subdivisions. Because of the large front end cost of installing conventional gravity sewers with no immediate return, developers prefer to utilize private septic tank systems to dispose of the wastewater. In older subdivisions, septic tank systems were often installed in unsuitable soils or constructed improperly, resulting in mass failures. The only solution has been to extend interceptor sewers to the subdivision from the nearby municipality.

This becomes a very costly proposition in several ways. The lack of an alternative forces the developer to subdivide land with relatively good soils. Not only does this often remove good agricultural land from production, but it also results in scattered development about a metropolitan center. The development will increase the tax base of the local government but the scattered development also increases the costs of providing other community services, such as roads, police and fire protection and other utilities. If septic tank system failure requires eventual extension of municipal sewerage for the outlying subdivisions, it becomes extremely costly, and also may be undesirable in some cases because of the strip growth that often occurs along the interceptor routes. The result may be a net economic and environmental loss to the community. The need for a cost-effective, yet viable alternative, is certainly indicated.

Though the results of these studies indicate that significant savings can be made by investigating other alternatives to conventional sewerage, there are several deterrents to their widespread acceptance. Biases of engineers, regulatory agencies and funding agencies favor central gravity sewers and treatment plants. Probably one of the greatest deterrents to the use of such facilities is technical knowledge and experience with the performance of relatively untried techniques. Innovative designs take more time to prepare and have more risk associated with them. Since engineering fees are usually based upon a percentage of the construction costs, there is little incentive to be innovative. The engineer gets paid less for doing more work and at a greater risk. Facilities like these need to be constructed and monitored to gain familiarity with non-central systems to increase their acceptance.

Regulatory agencies also favor conventional systems, due to confidence and familiarity in tried and proven methods. Innovative designs, therefore, take more time to review. Thus, the engineer is more likely to design a conventional facility that creates fewer stumbling blocks with the reviewing agency.

Another deterrent to acceptance of such facilities is the question of whether this type of plan would be eligible for federal and local construction grants. Certainly there is bias in favor of conventional sewerage, because of present component eligibility guidelines. Thus, while a conventional facility may be more costly because of its eligibility for construction grants, it becomes less costly to the subscribers. This bias is wasteful of tax dollar, as well as environmentally unsound, for it encourages communities to delay abatement efforts until funding is available.

Obviously, what is needed are additional planning studies of this nature, working with several communities or subdivisions each having different characteristics. Such studies would provide a data base to develop planning guidelines to determine the most cost-effective facility. Construction of several facilities would also increase experience with system performance to gain acceptance by engineers and the public. If it can be demonstrated that non-central facilities are effective, regulatory agencies also may see the need for a change in policy.

ACKNOWLEDGEMENTS

The assistance of Lester Forde, Research Assistant in the Department of Civil and Environmental Engineering, University of Wisconsin and Carl C. Crane, Inc., Consulting Engineers, in preparation of the Westboro facilities plan is appreciated. The legal research provided by David E. Stewart must also be recognized. The support given by the residents of Westboro was essential.

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